# **COST ESTIMATING GUIDE**



"Planning for Success!"

# **U.S. Department of Energy**

Office of Management, Budget and Evaluation

# **FOREWORD**

The mission of the Department of Energy's (DOE) Office of Engineering and Construction Management (OECM) is to:

- **Drive** value added change in the Department's project and facilities management systems
- **Provide** corporate processes for and oversight of the Department's projects and real property
- **Integrate** sound fiscal acquisition and business practices into our management of projects and facilities
- Support the Department's project managers

To attain this objective, DOE must develop and maintain accurate, reasonable, verifiable, supportable, and up to date life-cycle cost estimates for all programs and projects. The purpose of the *DOE Cost Estimating Guide* is to provide uniform guidance and best practices that describe methods, procedures, and formats for the preparation of cost estimates that are used in all programs and projects at DOE. The Guide is not intended to impose new requirements that are not already Department policy. The *Cost Estimating Guide* is applicable to all phases of the Department's Acquisition Management System and real property life-cycle asset management activities.

This guide is NOT intended to instruct federal employees "how-to" prepare life-cycle cost estimates. Rather, it provides guidance and information in using standard commercial estimating practices and processes that meet federal and DOE requirements; that are consistent with industry standards and practices; and that facilitate the development of local or site-specific requirements.

The *DOE Cost Estimating Guide* will be assessed and updated periodically to reflect the latest DOE requirements and industry developments. The DOE Cost Engineering Group (DOE-CEG) is responsible for maintaining the information in the *DOE Cost Estimating Guide* 

More information on OECM can be found at:

http://oecm.energy.gov/

More information on the DOE-CEG can be found at: http://oecm.energy.gov/cost\_estimating/cost\_index.html

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# **CHAPTER 1 - INTRODUCTION AND OVERVIEW**

Section 1.1 - Summary of Requirements

Section 1.2 – Industry Standards and Recommended Practices

Section 1.3 – The Project Life Cycle

Section 1.4 - Inputs, Processes, and Outputs

Section 1.5 - Roles and Responsibilities

CHAPTER 1 - INTRODUCTION AND OVERVIEW explains, in general terms, *why* we do cost estimates and *when* in a project's life cycle cost estimates are required; provides an overview of the cost estimating "knowledge area," including inputs, processes (tools and techniques), and outputs; and describes *who* is responsible for *what*, in terms of cost estimates used within DOE.



Throughout the *DOE Cost Estimating Guide* are boxes containing "Key Points," which indicate suggested practices that may not be well-known, but could be beneficial for future reference.

Some key terms used in this chapter include:

- Successful projects
- Federal requirements
- DOE requirements
- DOE Acquisition Management System
- Project life cycle
- Inputs, processes, and outputs

# **Section 1.1 - Summary of Requirements**

A key objective of DOE is to manage *successful projects and programs*. The objective of this guide is to improve the quality of cost estimates, in particular supporting the execution of successful projects and programs. This guide provides cost estimating principles and processes that meet federal and DOE requirements, are consistent with industry standards and practices, and facilitate local requirements. A more complete summary of the federal requirements may be found in Appendix 6–1.

Generally, federal requirements are promulgated by:

• Office of Management and Budget (OMB), which provides specifics for

budgeting, discount rates, and management of projects (acquisitions) in their Circulars

- The Federal Acquisition Regulation (FAR), which provides federal contract requirements. This includes such requirements as government estimates, cost and price analyses, and contract changes
- The Code of Federal Regulations (CFR), which provides requirements for alternative considerations and life-cycle cost analyses
- Various other federal laws, such as the Government Performance and Results Act (GPRA), the Government Management Reform Act (GMRA), the Federal Acquisition Reform Act (FARA), the Federal Acquisition Streamlining Act (FASA), the Information Technology Management Reform Act (ITMRA), the Chief Financial Officers Act (CFO Act), and others

These federal laws and policies drive the way DOE conducts business. DOE's Directives Management System is the means by which departmental policies, requirements, and responsibilities are developed and communicated. Directives are used to inform, direct, and guide employees in the performance of their jobs and enable employees to work effectively within the Department and with agencies, contractors, and the public. A summary of requirements from applicable DOE Orders may be found in Appendix 6–2.

The most significant, relevant DOE Orders include:

- DOE O 130.1—Budget Formulation
- DOE O 413.3—Program and Project Management for the Acquisition of Capital Assets
- DOE O 430.1b—Real Property Asset Management, Draft (RPAM)
- DOE O 520.1—Office of Chief Financial Officer
- DOE O 534.1—Accounting
- DOE O 542.1—Competition in Contracting

Each DOE program may have specific, detailed requirements for the DOE field offices to meet its needs. Examples include NEPA, safety and health, site security requirements, and local requirements, such as contracts, labor agreements, etc. Many of these requirements are implemented through the annual budget formulation and execution process. For instance, DOE's Budget Formulation Guidance includes very specific formats and directions for submitting Project Data Sheets and the OMB Exhibit 300, Capital Asset Plan and Business Case (See Appendix 6.6).

# **Section 1.2 - Industry Standards and Recommended Practices**

In the United States, responsibility for setting product and process standards rests almost exclusively with the private sector. Government agencies rely heavily on voluntary standards, which they often incorporate into regulatory and procurement requirements.

OMB defines "voluntary consensus standards" as:

standards developed or adopted by voluntary consensus-standards bodies, both domestic and international. These standards include provisions requiring that owners of relevant intellectual property have agreed to make that intellectual property available on a non-discriminatory, royalty-free or reasonable-royalty basis to all interested parties. For the purposes of this Circular, "technical standards that are developed or adopted by voluntary-consensus standard bodies" is an equivalent term.

The National Technology Transfer and Advancement Act (Public Law 104-113) mandates that federal departments and agencies use voluntary-consensus standards in place of Government standards wherever practical. For the purposes of this guide, voluntary-consensus standards include:

- ASTM E2150-02 Standard Classification for Life-Cycle Environmental Work Elements, Environmental Cost Element Structure
- ASTM E2083-00 Standard Classification for Building Construction Field Requirements and Office Overhead & Profit
- ASTM E2168-01 Standard Classification for Allowance, Contingency and Reserve Sums in Building Construction Estimating
- ASTM E2137-01 Standard Guide for Estimating Monetary Costs and Liabilities for Environmental Matters
- ANSI Z94.4-1998 Cost Engineering and Project Management (developed by the Institute of Industrial Engineers)

Industry standards are not necessarily requirements, although their use and reference are essential to incorporate the best commercial business practices into government procedures. This *DOE Cost Estimating Guide* strives to incorporate best practices contained in commercial quality standards (ANSI/EIA, ASTM, etc.) and recommended practices (e.g., the Project Management Institute, the Association for the Advancement of Cost Engineering, the Society of Cost Estimating and Analysis, and the Construction Industry Institute).

For that reason, DOE has cooperative agreements with the Project Management Institute (PMI) and the Association for the Advancement of Cost Engineering, International (AACE) to promote the use of these industry standards. Several sections within this guide will reference information from both PMI and AACE.

PMI's A Guide to the Project Management Body of Knowledge (PMBOK® Guide, 2000 Edition) describes projects using process groups: Initiating, Planning, Executing, Controlling, and Closing. These processes are linked by their results, so the completion of one process group usually indicates the beginning of another. For example, "Planning" results in a project plan that is "Executed." Also, PMI explains the interactions (inputs, tools and techniques, and outputs) of the processes within each of its nine knowledge areas (Integration, Scope, Time, Cost Quality, Human Resources, Communications, Risk, and Procurement). The Cost Estimating Guide acknowledges PMI's Cost Management knowledge area, and it is organized by inputs, processes, and outputs.

AACE has established *Recommended Practices* for various aspects of the Cost Engineering field. Among those Recommended Practices, 17R97 and 18R97 depict cost estimate classifications and their characteristics. For this guide, these Recommended Practices are being referenced and are included in Appendices 6.3 and 6.4. DOE's Joint Agreement with AACE, dated August 2, 2002, includes objectives to:

- Advance the "state-of-the-art" of Total Cost Management through increased communication and dialogue at the national and local section level, including involvement in committees and discussion groups
- Apply established cost engineering and cost management principles, proven methodologies, and the latest technology in support of management processes
- Develop new cost engineering and cost management methodologies and technology in pursuit of optimum resource utilization
- Enhance the exchange of information, methodologies, and technologies to increase cost management and control
- Encourage the utilization of cost management standards and practices and their continual improvement and advancement
- Facilitate communication and understanding of the issues involved in and obstacles to the effective planning and control of costs, resources, and risks
- Promote continued advancement and education in the skills and practice of Total Cost Management to ensure the use of the most advanced and up-to-date methods and technology
- Encourage accredited certification of cost management professionals to increase the public's confidence in the cost management of government programs

More information on the DOE Directives system may be found at: http://www.directives.doe.gov/

More information on DOF Budget Formulation may be for

More information on DOE Budget Formulation may be found at: <a href="http://www.mbe.doe.gov/budget/">http://www.mbe.doe.gov/budget/</a>

More information on OMB A-11 and Exhibit 300 may be found at: http://www.whitehouse.gov/omb/circulars/index-budget.html

More information on PMI may be found at:

http://www.pmi.org/info/default.asp

More information on AACE may be found at: http://www.aacei.org/

# **Section 1.3 – The Project Life Cycle**

During the life of a project, cost estimates and related documents are required to facilitate the project's acquisition process, document project planning and development, and document changes required throughout the project. Many cost estimating documents are depicted in Figure 1–1.

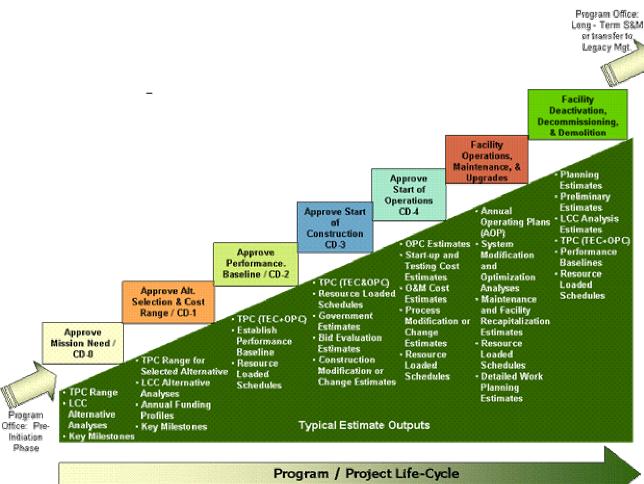


Figure 1-1. Project/Program Life-Cycle Stages

Derived from information contained in the *DOE Project Management Manual* and other DOE requirements, cost estimates are required for:

- Critical Decision (CD)-0 Approve Mission Need Normally, cost estimates prepared to support CD-0 will be Class 5 - Order of Magnitude and may utilize several techniques in development. There will likely be very little detail to support these cost estimates, so scope assumptions should be documented as necessary. A range should be established based on project alternatives. Normally, depending on techniques used, there will be little, if any, distinction between components or categories within the cost estimate (e.g., direct costs, indirect costs, contingency, or escalation; labor, materials, equipment, etc.; types of work).
- CD-1 Approve Alternative Selection and Cost Range
   Cost estimates prepared to support CD-1 will likely be Class 5 Order of
   Magnitude to Class 3 Preliminary cost estimates, utilizing several cost
   estimating techniques. For alternatives explored, varying levels of available
   information should be expected. Ranges should be a little more refined than those

at CD-0, but still established based on the range of project alternatives.

## • CD-2 - Approve Performance Baseline

Cost Estimates supporting CD-2 will likely be Class 3 - Preliminary to Class 1 - Definitive and utilize more of the definitive cost estimating techniques. For CD-2, since information available will be well developed, there will no longer be a range. A single cost estimate will represent the entire project, utilizing the preferred alternatives established earlier in the project.

With approval of CD-2, a Performance Baseline is established for the project, along with the Contract Budget Base, the Performance Measurement Baseline (PMB), Management Reserve, Control Accounts, and Undistributed Budget.

#### • Various Contract Actions

During the normal course of a project or program, contract actions are inevitable, whether they are prime DOE contract actions or subcontract actions. Contract actions commonly entail a government estimate, a proposed estimate, and some agreed-to estimates. Depending on contract types and other factors, varying levels of information will be available, facilitating the use of varying cost estimate classifications and techniques in cost estimate development.

## Various Budget Actions

During the normal course of a project or program, budgets are sometimes adjusted due to appropriations and allocation being more or less than expected. Some cases require estimated what-if scenarios to depict alternative courses: "What happens if . . . ?" As budgets are adjusted, baselines and estimates for current-period work (work packages) should also be adjusted accordingly.

## • Various Project Changes

During the normal course of a project or program, cost estimates are required to support project management decisions. In many cases, alternatives are considered that do not affect the entire project but do affect the day-to-day details of managing a project, for instance, detail changes that do not exceed a cost or schedule threshold for management approval.

#### • Life-Cycle Cost Analysis

Life-Cycle Cost Analysis (or Cost-Benefit Analysis, Economic Analysis, etc.) is required for many purposes. For the Critical Decision process, analysis is required at each decision point to ensure that correct paths are taken. As a part of alternative selection, Life Cycle Cost Analysis will formally point to the alternative with the lowest life-cycle cost. Any time a project encounters a change, or finds some alternative to be considered, Life Cycle Cost Analysis should be considered.

Cost estimates for program activities are an integral part of the Department's Planning, Programming, Budgeting, and Evaluation (PPBE) process. The PPBE process provides a systematic framework for prioritizing program needs, allocating resources, measuring performance, and delivering results. Accurate cost estimates are critical to the Department's ability to successfully plan and execute its missions.

All Departmental elements prepare estimates on an annual basis to account for planned expenditures related to required program operating expenses (OE), plant acquisition and construction (PL) activities, capital equipment not related to construction (CE), and capital asset acquisition activities. These estimates not only support the planning and budgeting processes, they also provide the yardstick against which the cost performance of a program or project is measured.

The standard cost estimating practices and techniques presented throughout this guide should also be used when developing estimates required for Working Capital Fund (WCF) activities, General Plant Projects (GPP), Institutional General Plant Projects (IGPP), Research and Development (R&D), Project Engineering and Design (PED), Construction Management (CM), Project Management (PM), Information Technology (IT), Other Project Costs (OPC), annual facility operations, maintenance and repair, recapitalization, programmatic operating activities directed related to facility operations, deactivation, demolition, and legacy management. Cost estimates developed using the practices and techniques presented herein may also be components of Ten-Year Site Plans (TYSP), disposition plans for closure sites, Integrated Facilities and Infrastructure (IFI) Crosscut Budgets, Annual Operating Plans (AOP), Current-Year Work Plans (CYWP), Detailed Work Plans (DWP), or other applicable business-related processes used by the Department.

DOE's Project Management Manual can be found at: <a href="http://www.directives.doe.gov/pdfs/doe/doetext/neword/413/m4133-1.html">http://www.directives.doe.gov/pdfs/doe/doetext/neword/413/m4133-1.html</a>

# Section 1.4 - Inputs, Processes, and Outputs

Traditionally, cost estimates are developed by gathering inputs, going through the process of developing the cost estimate and its documentation, and generating necessary outputs. Figure 1–2 depicts the cost estimate development process, which should be similar for cost estimates at various points within the project life cycle. Cost estimates, schedules, risk management plans, and peer reviews are very closely related. None should stand alone.

Risk Management Plan

Input

Peer Reviews

Output

Output

Output

Figure 1–2. Cost Estimating Process

These process interactions—inputs, processes (tools and techniques), and outputs—are used by PMI and others to depict the transfer of information between steps in a knowledge area, like cost estimating. This graphic depicts these interactions and is the basis for the organization of this guide. Inputs are discussed in chapter two; the processes, or cost estimate development and documentation, are discussed in chapter three; and the outputs, or uses of cost estimates, are discussed in chapter four.

# Section 1.5 - Roles and Responsibilities

Guides do not contain requirements. As such, this guide is intended to be used by DOE and contractor cost estimators, project directors, project managers, and other personnel involved in the acquisition and operations of DOE facilities. Each prime DOE contractor and individual DOE field and program office should incorporate this guide into their operating procedures to ensure consistency and standardization across the DOE.

Although this guide does not provide explicit "how-to" information, it is expected that DOE and contractor personnel at respective DOE sites and field offices use it to obtain a working knowledge of cost estimating and analysis, including how cost estimates are used throughout the planning and execution of DOE missions. Table 1–1 provides a listing of roles and responsibilities for those involved in cost estimating for the department.

Table 1-1. Roles and Responsibilities

Roles	Responsibilities		
DOE-OECM	Maintains DOE policy and requirements for acquisitions, or projects.		
	• Sponsors the DOE-Cost Engineering Group (DOE-CEG).		
DOE-CEG, by charter	<ul> <li>Maintains the DOE Cost Estimating Guide and other activities as directed by OECM.</li> </ul>		
	• Includes federal and contractor project management and cost estimating representatives.		
	<ul> <li>Promotes cost estimating consistency and standardization across the DOE complex.</li> </ul>		
	<ul> <li>Promotes the use of industry standards and commercial/corporate experience to establish effective benchmarks.</li> </ul>		
DOE Headquarter Program Offices	Maintain the missions of the DOE.		
	<ul> <li>Provide, as required, program-specific guidance to implement DOE's policies and requirements.</li> </ul>		
	• Responsible for Internal Project Reviews (IPRs) and validations.		
	• Participate in the DOE-CEG.		

Roles	Responsibilities
DOE site offices, including DOE Project Directors and Integrated Project Teams (IPTs)	<ul> <li>Implement missions of the DOE.</li> <li>Submit budgets, administer contracts, and manage projects in implementing DOE missions.</li> <li>Provide, as required, more specific guidance to implement DOE's policies and requirements.</li> <li>Responsible for cost estimate reviews and validations.</li> <li>Typically own cost estimates.</li> <li>Participate in the DOE-CEG.</li> </ul>
Contractors	<ul> <li>Assist DOE in implementing its missions.</li> <li>Comply with DOE requirements and meet cost estimating expectations. More specifically, develop various cost estimates for budgeting, contracting, alternative analysis, etc., to be used by DOE.</li> <li>Typically prepare cost estimates for DOE site offices.</li> <li>Participate in the DOE-CEG.</li> </ul>

## **Integrated Project Teams (IPT)**

An IPT is a cross-functional group of individuals organized for the specific purpose of delivering a project to an external or internal customer. Team members are representative of all competencies that influence the project's overall performance. IPTs are expected to include cost estimating professionals.

The IPT should be committed to a common purpose and approach for which members hold themselves mutually accountable. Team members are trained by their home departments/organizations to execute standard processes and exercise technical and/or business judgment within established policies in support of the assigned project.

Members of an IPT represent technical, manufacturing, business, contracting, and support functions and organizations that are critical to developing, procuring, and supporting the product. Depending on the project needs, typical IPT membership could include legal, quality, safety, environmental, and technical personnel.

If possible, IPT members are assigned for the length of time required to complete their IPT assignments. Therefore, depending on the relative impact of a team competency, team membership may be either full-time or part-time.

An IPT is the means by which the acquisition process is implemented. The IPT is the overall project support team having responsibility for pre-project and project development, design/engineering, and construction/remediation activities, as appropriate. As a project progresses from Initiation to Transition/Closeout completion, IPT membership may, at the discretion of the project manager (PM), change in both members and capabilities to remain responsive to project needs and requirements.

Cost estimators and cost engineers participating in an IPT should be cognizant of the relationships with other functional areas, such as budgeting, finance, contracting, etc.

# **CHAPTER 2 - COST ESTIMATING INPUTS**

SECTION 2.1 - PROJECT INTERFACES

**SECTION 2.2 - CONTRACT TYPES** 

SECTION 2.3 - COST ESTIMATE PURPOSES

SECTION 2.4 - COST ESTIMATE CLASSIFICATIONS

SECTION 2.5 - COST ESTIMATE TECHNIQUES

In Chapter 2 - Cost Estimating Inputs, Figure 2–1, Cost Estimating Process, provides an understanding of what generally happens (or should happen) early in the development of a cost estimate. Chapter 2 goes on to explain some of the project interfaces (both one-time and iterative), contract types utilized, cost estimate purposes, classifications, and techniques.

Schedule Risk Management Plan

Output

Peer Reviews Of Work

Figure 2–1. Cost Estimating Process

Some key terms and concepts used in this chapter include:

- Interfaces
- Performance-based contracting
- Government estimates
- Contract types
- Cost estimate purposes
- Cost estimate classifications
- Cost estimate ranges
- Cost estimate techniques

# **Section 2.1 - Project Interfaces**

Cost estimate development is initiated by *inputs* to the process. These inputs are either one-time or iterative processes. One-time inputs may include (but are not limited to) the Project Charter, Project Execution Plan, Acquisition Strategy, and the Acquisition Plan. One-time inputs to the Cost Estimating Process will not necessarily evolve with the Cost Estimating Process.

Other inputs are iterative and do evolve through the Cost Estimating Process. They include risk identification and mitigation strategies, schedule, and technical/scope development. Peer reviews, too, are iterative, since input to and by cost estimating peers may affect the quality of the cost estimate. Peer reviews should be required before any external reviews are conducted. Peer reviews are discussed in more depth in chapter three.

# **Section 2.2 - Contract Types**

There is a requirement for *government estimates* prior to most contracting activities. Government estimates may become the basis for contract negotiations or become important in the case of settling claims. Government estimates, like all other estimates used within DOE, should follow this Cost Estimating Process.

Before determining the content of an estimate, it is pertinent to understand the contract types that will be used to execute the work. "Contract type" determines the activities and cost accounts to be established and reported. Contract types typically reflect a level of technical definition, size, and complexity of activities, and are based on an established scope of work. The contract type that will be used to execute the work may be affected by a program's acquisition strategy, but it may also be specific to a particular project or the activities within a project. Contract types are discussed later and shown in Table 2–1.

Most DOE projects fall into the category of Cost-Reimbursable contracts. Generally, fee determination in a Cost-Reimbursable (cost-plus) contract distinguishes whether it is performance based. In order to fulfill mission needs, DOE programs and projects are responsible for the planning and procurement of contracts. *Performance-based contracting* is a preferred contracting method that requires discrete, quantifiable, and measurable objectives tied to an incentive fee. A project baseline (established at CD-2) and near-term contracts, or work packages, should also have characteristics that are discrete, quantifiable, and measurable.

Cost-Plus-a-Percentage-of-Cost contracts are typically not allowed for government work, because the incentive on this type of contract is to increase costs. Table 2–1 illustrates some common contract types and their respective characteristics. There may be variations to these contract types.

Common to DOE's large contracts are the Management and Operating (M&O) contracts and the Management and Integration (M&I) contracts. Most DOE work is contracted to universities and corporations, utilizing M&O and M&I contracts, and small businesses, as appropriate. However, DOE also has numerous Fixed Price and other contract types in place, all dependent on the project or contract level of definition and technical risks.

All of these contract types have some aspect of performance tied to them. Performance objectives are easiest to quantify and measure in projects with definitive scopes of work.

Table 2–1. Contract Types

Type of Contract	Characteristics
Fixed Price or Lump Sum	Includes material, labor, equipment, subcontracts, indirect costs, overhead, profit, contingency, and escalation. These are typically well defined and include low technical risks.
Cost-Plus Fixed Fee	Includes reimbursement for material, labor, equipment, subcontracts, indirect costs, overhead, and escalation. Fee is NOT determined by performance; it is fixed. Contingency is used for planning as necessary.
Cost-Plus Award Fee	Includes reimbursement for material, labor, equipment, subcontracts, indirect costs, overhead, and escalation. Fee is determined by performance. Cost-Plus Award is the most <i>subjective</i> of the Cost-Plus contract types. Contingency is used for planning as necessary.
Cost-Plus Incentive Fee	Includes reimbursement for material, labor, equipment, subcontracts, indirect costs, overhead, and escalation. Fee is determined by performance. Cost-Plus Incentive is the most <i>objective</i> of the Cost-Plus contract types. Contingency is used for planning as necessary.
Labor Hour Contracts	Material, labor, equipment, subcontracts, indirect costs, overhead, profit, and escalation are rolled into an hourly labor rate.  Contingency may be reflected in the estimated number of labor hours.
Unit Cost Contracts	Material, labor, equipment, subcontracts, indirect costs, overhead, profit, and escalation are rolled into costs per unit. Contingency may be reflected in estimated quantities.
Task-Order Contracts	Similar to Labor Hour contracts, except oriented to specific tasks.

**©**Key Point

Design-Build contracts may be managed as Fixed-Price or Cost-Reimbursable contracts (or subcontracts) and should be:

- Commensurate with the project's size, complexity, risks, and maturity
- Appropriate for the project's situation
- Consistent with the project's acquisition strategy

Profit, or fee, may be included in a site indirect rate (see Section 3.2.2 - Indirect Costs), depending on contract type, financial system, or other specific circumstance. *Fee* is normally associated with Cost-Plus contracts, where fee is determined based on preestablished performance objectives or an assessment of other criteria (e.g., Cost-Plus-Incentive-Fee). *Profit* is normally associated with a Fixed-Price contract, wherein profit is unknown until all costs have been incurred. Profit is sometimes referred to as the "wages of risk." Both fee and profit should be commensurate with the risks involved.

# **Section 2.3 - Cost Estimate Purposes**

Cost estimates and life cycle cost analyses are produced for many reasons. These purposes include support to:

- 1. The Critical Decision (CD) Process within programs/projects (DOE O 430.1 and DOE O 413.3)
- 2. The annual budget process (DOE O 130.1 Budget Formulation)
- 3. Contract actions (DOE O 542.1 Competition in Contracting)
- 4. Other project/program management purposes (various federal regulations, DOE Orders, and industry practices). This includes the development of economic analysis, cost-benefit analysis, life cycle cost analysis, Value Engineering (VE) studies, Earned Value (EV) analysis, and support of change control. Some of these topics are discussed more specifically in later chapters.

Summaries of the federal and DOE requirements can be found in Appendix 6.1 and 6.2.

#### **Section 2.4 - Cost Estimate Classifications**

The five DOE eost estimate classifications are based on AACE's "Recommended Practice for Classifying Cost Estimates" (AACE International Recommended Practice No. 17R-97, , see Appendix 6.3). They are listed in Table 2–2, along with their primary characteristics.

Appendix 6.4, AACE's Recommended Practice No. 18R-97, includes a more complete description of AACE's classifications. DOE's cost estimate classifications follow these recommended practices, generally, although historically the more common cost estimate classifications are Order of Magnitude, Preliminary, and Definitive, which approximately

equate to Classifications 5, 3, and 1, respectively.

Cost estimates have common characteristics, regardless of whether the technical scope is more traditional (capital-funded, construction-type) or more non-traditional (expense-funded, operations-type). The common characteristics are levels of definition, requirements, and techniques. Typically, as a project evolves, it becomes more definitive. Cost estimates depicting these evolving projects also become more definitive over time.

The cost estimate classifications may be used with any type of traditional or non-traditional project and include consideration of:

- Where a project stands in its life cycle
- Level of definition (amount of information available)
- Techniques to be used in estimation (e.g., Parametric vs. Definitive)
- Time constraints and other estimating variables

Determination of cost estimate classifications will help ensure that cost estimate *quality* is appropriately considered. Cost estimate classifications may also help determine: appropriate application of contingency, escalation, use of direct/indirect costs (as determined by cost estimate techniques), etc.

Table 2-2. Cost Estimate Classifications

	Primary Characteristics		
Cost Estimate Classification	Level of Definition (% of Complete Definition)	Examples of Use	Cost Estimating Description (Techniques)
Class 5 - Order of Magnitude	0% to 2%	To establish ranges supporting CD-0, mission need	Stochastic, most Parametric, judgment (Parametric, Specific Analogy, Expert Opinion, Trend Analysis)
Class 4 - Intermediate	1% to 15%	Intermediate estimate; seldom used	Various, more Parametric (Parametric, Specific Analogy, Expert Opinion, Trend Analysis)
Class 3 - Preliminary	10% to 40%	CD-1, preliminary baseline approval and CD-2, baseline approval	Various, including combinations (Detailed, Unit-Cost, or Activity-Based; Parametric; Specific Analogy; Expert Opinion; Trend Analysis)
Class 2 - Intermediate	30% to 70%	Intermediate Estimate, Seldom Used	Various, more Definitive (Detailed, Unit- Cost, Or Activity-Based; Expert Opinion; Learning Curve)
Class 1 - Definitive	50% to 100%	CD-3, construction start	Deterministic, most Definitive (Detailed, Unit-Cost, Or Activity-Based; Expert Opinion; Learning Curve)

Note: Because of the subjective nature of accuracy levels, confidence levels, and preparation effort, they are not included in this table.

## **Class 5 - Order of Magnitude Cost Estimates**

Class 5 - Order of Magnitude cost estimates, also known as Rough Order of Magnitude (ROM) or Top-Down cost estimates, are typically performed in the early stages of a project's life, such as supporting a CD-0, Approval of Mission Need. These cost estimates are based on the least amount of available information and may portray a low level of confidence or accuracy.



As a general rule, even for projects in early stages of development, cost estimate classification should reflect more definitive scope development for the near-term portions of work. This may be referred to as "rolling-wave" planning, where detailed planning of future work is done in increments, or waves, as the project progresses through phases.

For instance, cost estimates supporting a CD-1 may include:

- Class 1 Definitive cost estimates, and scope for more-defined near-term work (e.g., the design and scope development phases)
- Class 5 Order-of-Magnitude cost estimates for the less-defined long-term work (execution, construction, and project close-out phases)

#### Class 4 - Intermediate

Class 4 – Intermediate cost estimates are seldom used, but could typically include a combination of Class 5 and Class 3 cost estimates.

#### Class 3 - Preliminary

Class 3 - Preliminary, or Budgetary, cost estimates are those typically required to support a CD-1 preliminary baseline and CD-2 baseline approval. These cost estimates contain diverse levels of available and supporting information, use various techniques, and portray a moderate level of confidence.

#### **Class 2 - Intermediate**

Class 2 – Intermediate cost estimates are seldom used, but could typically include a combination of Class 3 and Class 1 cost estimates.

#### **Class 1 - Definitive**

Class 1 - Definitive cost estimates, also known as Detailed, Detailed Unit-Cost, or Activity-Based cost estimates, are those with the most abundantly available support information, typically using a definitive technique for development and representing a greater level of confidence.

As a general rule, particularly for projects that are in the early stages of development, a combination of estimate classifications must be used to develop the entire life cycle cost

estimate. In these situations, estimators should use a combination of detailed unit cost estimating (Class 1) techniques for work that will be executed in the near future, preliminary estimating (Class 3) techniques for work that is currently in the planning stages but less defined, and Order of Magnitude estimating (Class 5) techniques for future work that has not been well defined. As a project progresses through the Acquisition Management System (initiation, definition, execution, and transition/closeout phases and the project development and planning matures, the life cycle cost estimate becomes more definitive in nature and substance.

For example, if a project is nearing the end of the definition phase (CD-1 Approval of Mission Need), the project estimate will likely be composed of the three common estimate classes, as follows:

- Class 1 Definitive estimates for the activities that will be executed in the near term (e.g., design and scope development activities)
- Class 3 Preliminary estimates to establish the performance baseline and construct the asset
- Class 5 Order of Magnitude estimates that capture start-up, testing, turnover, project close-out, and operations, and ultimate disposition for the planned asset

# **Cost Estimate Ranges**

DOE Order 413.3 requires the use of ranges to express project cost estimates. These ranges should depict the project's Total Project Costs (TPC) in the early stages of the project (i.e., at CD-0 and CD-1), normally before the commitment to a Performance Baseline (PB) at CD-2. Ranges should be shown in escalated dollars and may be determined or based upon various:

- 1) Project alternatives
- 2) Projected risks
- 3) Confidence levels (Remember: "Planning for Success!")

The Department's Acquisition Management System includes CD points that identify exit points from one phase of project development to entry into the succeeding project phase.

During the project initiation phase (CD-0), the program defines the capability it needs to acquire. The program must also provide a cost range and timeline that include key milestones and a profile of anticipated funding requirements, based on the upper bound of the cost estimate. It is important to note that, during the project initiation phase, the mission need is defined in terms of needed capability rather than the specific acquisition of a capital asset. During this phase of a project, many alternatives will be evaluated to meet the identified need.

The cost range developed at this point in the project planning process will represent a cost range for all viable alternatives considered to achieve the required performance capability. These estimates should also include costs for exploring alternative concepts and the development of solutions and alternatives during the project definition phase.

Life cycle cost estimates that are developed to support mission need statements and obtain CD-0 are not engineering derived, but they must be sufficiently developed to

support budget requests for the remainder of the project definition phase. They should also include all anticipated resources, using appropriate estimating techniques that are necessary to acquire or meet the identified capability.

During the project definition phase, at the conclusion of the concept exploration process, the alternative selected as the best solution to a mission need is presented for approval (CD-1). The solution presented as a subset of the Conceptual Design Report (CDR) must include the total project cost range, a schedule range with key milestones and events, and annual funding profiles. The total project cost range presented must be a risk-adjusted cost estimate that defines all required resources necessary to successfully execute the planned work.

The estimate range (lower and upper bounds) is established by considering the risk analysis conducted by the IPT. The risk analysis is analytical in nature and, while simulation tools aid the analyst in assessing impact and consequences, no simulation tool can substitute for a logical deterministic process. The risks are identified by the likelihood of occurrence and the probable impact if the risk occurs.

The lower bound of the cost range will likely represent a scenario where the IPT has determined a low likelihood of occurrence of identified risks. The risks are accepted; therefore it is not necessary to include resources to mitigate them. The upper bound of the cost range will likely represent a scenario where the IPT has determined a high likelihood of occurrence of identified risks. The risks will be planned for and managed and appropriate resources to mitigate them are included.

# **Section 2.5 - Cost Estimate Techniques**

Several cost estimating techniques are available to facilitate the Cost Estimating Process. Depending on project scope, estimate purpose, project maturity, and availability of cost estimating resources, the estimator may use one, or a combination, of these techniques. The following sections include techniques that may be employed in developing cost estimates.

#### Section 2.5.1 - Detailed, Unit-Cost, or Activity-Based

Detailed, Unit-Cost, or Activity-Based cost estimates are the most definitive of the estimate techniques and use information down to the lowest level of detail available. They are also the most commonly understood and utilized estimating techniques.

The accuracy of Detailed, Unit-Cost, or Activity-Based techniques depends on the accuracy of available information. A work statement and set of drawings or specifications may be used to identify activities that make up the project. Each activity is further broken down so that labor hours, material costs, equipment costs, and subcontract costs (or other unit-cost-type items) are itemized and quantified. Subtotaled, these form direct costs. Indirect costs, overhead costs, contingency, and escalation are then added as necessary. The estimate may be revised as known details are refined. The Detailed, Unit-Cost, or Activity-Based estimating techniques are most used for Class 1 and Class 2 cost estimates.

Activity-Based cost estimates (or ABC estimates), detailed cost estimates, check

estimates, bid estimates, construction estimates, and other terms imply that activities, tasks, work packages, or planning packages (the lowest level of the WBS) are well-defined, quantifiable, and are to be tracked, so that performance can accurately be measured. Quantities should be objective, discreet, and measurable.

## Section 2.5.2 - Parametric, or Top-Down

Parametric estimating produces higher-level estimates when little information, other than basic parameters, is known about a project. For example, a building's cost can be estimated given only its size, purpose, and general site information.

A Parametric estimate requires the use of Cost Estimating Relationships (CERs, also known as cost models, composites, or assemblies/subassemblies), which are developed from historical data by similar systems or subsystems. CERs are correlations between cost drivers and system parameters, such as design or performance requirements (a quantity of something). A CER can be used individually or grouped into more complex models.

Parametric estimates are commonly used in conceptual and check estimates and are normally developed using computerized software. A limitation of the use of CERs is that, to be most effective, one must understand completely how the CER was developed and where and how indirect costs, overhead costs, contingency, and escalation are applicable. The Parametric estimating technique is most appropriate for Classifications 5, 4, and 3 cost estimates. The Parametric technique is best used when the design basis has evolved very little detail, but the overall parameters have been established.

#### Section 2.5.3 - Level-of-Effort

A form of Parametric estimating is Level-of-Effort (LOE). Historically, LOE is used to project future operations costs based on past operations costs. For example, "We spent ~\$10M on operations last year, so we need ~\$10M next year." Normally, but not in all cases, there are few parameters or performance objectives provided from which to measure or estimate. They are normally based on hours, Full-Time Equivalents (FTEs), or "1 lots." LOE estimates are often subject to scrutiny since they are perceived to have little objective basis. The keys to LOE estimates are that they should (1) generally be based on known scope (although particular quantities may be assumed) and (2) have a basis, even if it's simply the opinion of an expert or the project team (see the other estimating techniques).

Parametric and LOE estimates are used in two contexts: (1) where there is not much known about a particular thing or activity or (2) where the productivity and costs of an activity are carried for several time periods at a similar rate (e.g., the costs of operations, such as 'x' number of operators for some 'y' amount of time). In many cases, LOE estimates are performed simply due to lack of time to prepare a thorough cost estimate. LOE estimates are most appropriate for parts of a project where there is little empirical data to support things such as material unit costs, labor productivity, or equipment usage in installation. Determining LOE may also rely on input from the project team to establish approximate scope, costs, and schedule to be attributed to the particular WBS or COA.

Variations on LOE are many and should be considered carefully before using. For instance, if you have an LOE for motor installation, it may be questionable why it does not include the circumstances surrounding its installation (contamination and security productivity adjustments). Also questionable are indirect costs, overhead costs, profit/fee, and assumptions leading up to the LOE cost estimate.

## **Section 2.5.4 - Specific Analogy**

Specific Analogies use the known cost or schedule of an item as an estimate for a similar item in a new system. Adjustments are made to known costs to account for differences in relative complexities of performance, design, and operational characteristics.

A variation of this technique is the "review and update technique," where an estimate is constructed by examining previous estimates of the same or similar projects for logic, scope completion, assumptions, and other estimating techniques, and then updated to reflect any pertinent differences. The Specific Analogy technique is most appropriate in the early stages of a project, for Classifications 5 and 3, Order of Magnitude and Preliminary cost estimates.

## **Section 2.5.5 - Expert Opinion**

Expert Opinion is an estimating technique whereby specialists are consulted until a consensus can be established regarding the cost of a program, project, sub-project, task, or activity. The Expert Opinion technique is most appropriate in the early stages of a project, for Classifications 5, 4, and 3, Order of Magnitude, Intermediate, and Preliminary cost estimates. These cost estimates include a list of the experts consulted, their relevant experience, and the basis for their opinions.

A formalized procedure, called the Oracle Method, has been used to forecast cost based on Expert Opinion. Six or more experts are given a specific, usually quantifiable, question. Each expert sees the estimates of each of the others, and then modifies his previous estimate. If no consensus is reached after four rounds, the original question may be broken into smaller questions for further rounds of discussion, or a moderator may attempt to produce a final estimate.

This technique may be used for entire estimates or portions of estimates, including activities for which there is no other sound basis. A limitation may be the instance where a cost estimator's or project manager's status as an "expert" is questioned.

#### Section 2.5.6 - Trend Analysis

Trend Analysis is an estimating technique utilizing current, in-progress work. A trend is established using an efficiency index derived by comparing originally planned costs (or schedules) against actual costs (or schedules) for work performed-to-date. The derived cost/schedule indices are used to adjust estimate of work not yet completed.

The Trend Analysis technique of cost estimating can be used in most any stage of project development. Trend Analysis can even be used to update cost estimates developed using other techniques.

## Section 2.5.7 – The Learning Curve

The learning curve is a way to understand the efficiency of producing or delivering large quantities. It has been studied and proven that people engaged in repetitive tasks will improve their performance over time, that is, for large quantities of time and units, labor costs will decrease, per unit.

The aircraft industry first recognized and named the learning curve and successfully utilized it in estimating. It can be used most effectively when new procedures are being fielded and where labor costs are a significant percentage of total unit cost. But it should always be understood that the learning curve applies only to direct labor input; materials and overheads will not necessarily be affected by the learning curve. Figure 2–2 illustrates the theoretical use of the learning curve.

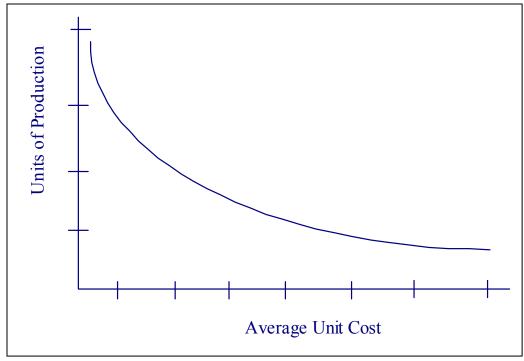


Figure 2-2. The Learning Curve

Typical learning curves start with high labor hours that decrease rapidly on initial units and then level out. This exponential relationship between "labor productivity and cumulative production is generally expressed in terms of labor reductions experienced when production is doubled." For example, a 90% learning curve function requires only 90% of the labor hours per unit each time production doubles. When a total of 200 units are produced, labor costs for the second 100 units will be only nine tenths the cost of the first 100.

Increased productivity allows for lower labor costs later in a project, and thus lowered overall project costs. Subsequent similar projects should have fewer labor hours for each unit of production also; this potentially allows for more contractor profit and lower government contract costs.

No standard reduction rate applies to all programs, and learning curve benefits will vary. When labor hour reductions of the first units are known, an accurate percentage reduction can be calculated and extended to subsequent units. If no data exists, it may be risky to assume that learning curve savings will be experienced.

The learning curve estimating technique is applicable for consideration in all traditional and non-traditional projects. The learning curve has been proven to be effective in the most repetitive projects and activities. The learning curve is also used to update labor hours used in previous cost estimates.

## Section 2.5.8 - Methods of Estimating Other Life-Cycle Costs

Different methods may be used to estimate other project/program support costs, including design, engineering, inspections, ES&H, etc. Some common methods are: Count Drawings and Specifications, Full-Time Equivalents (FTE), and Percentage.

## **Count Drawings and Specifications Method**

When using this method, the estimator calculates the number of drawings and specifications representing a specific project. The more complex a project is, the more drawings and specifications it will require, and, therefore, the more design costs will be associated with it.

## **Full-Time Equivalent Method**

The FTE method utilizes the number of individuals that are anticipated to perform the design functions of a project. The man-hour quantity is calculated and multiplied by the cost per labor hour and the duration of the project to arrive at the cost.

#### **Percentage Method**

When using this method, the estimator simply calculates a certain percentage of the direct costs and assigns this amount to the design. Former federal statutes limited the A/E portions of design costs to 6% of construction costs. Although this statute may be outdated, it is still good practice to limit this spending, to the extent practical. Total design percentages are usually 15–25%.

# **CHAPTER 3 - COST ESTIMATING PROCESSES**

**SECTION 3.1 - COST ESTIMATE DEVELOPMENT** 

**SECTION 3.2 - COST ESTIMATE CONTENTS** 

**SECTION 3.3 - REVIEWS** 

Each section of Chapter 3 - Cost Estimating Processes is important, because it describes how information is obtained (as described in Chapter 2 - Cost Estimating Inputs) and then becomes a product (as described later, in Chapter 4 - Cost Estimating Outputs). Chapter 3 discusses these processes and provides useful information on information gathering, cost estimate production, documentation, cost estimate contents, and reviews.

Some key terms used in this chapter include:

- Cost estimate
- Cost estimating
- Work breakdown structure (WBS)
- Code of accounts (COA)
- Basis of estimate
- Direct cost
- Indirect cost

- Management reserve
- Contingency
- Escalation rates
- Discount rates
- Activity
- Schedule
- Reconciliation
- Allowances

- Deterministic vs. Probabilistic
- Reviews
- Objective vs. Subjective
- Ranges

# **Section 3.1 - Cost Estimate Development**

Cost estimate development, as described in this section and as shown below in Figure 3–1, has three primary phases: *Information Gathering*, which consists of one-time and iterative inputs; cost estimate *Production*, and *Documentation*, which includes a cost estimate's basis of estimate. Cost Estimate Contents are contained in Section 3.2 and Reviews are discussed in Section 3.3.



Figure 3–1. Cost Estimating Process

A cost estimate . . .

- Is a compilation of all the costs of the elements of a project or effort included within an agreed-upon scope
- Is the yardstick against which cost performance is measured

And, consequently, cost estimating is . . .

• A predictive process used to quantify, cost, and price the resources required by the scope of an asset investment option, activity, or project

As a predictive process, estimating must address risks and uncertainties. The outputs of estimating are used primarily as inputs for budgeting, cost or value analysis, decision making in business, asset and project planning, or for project cost and schedule control processes.

#### **Section 3.1.1 - Information Gathering**

When given the task of developing an estimate, an estimator must first gather general project information, including:

- Project background
- Where the project stands in its life cycle
- General description of the technical scope
- Pertinent contract or sub-contract information
- Estimate purpose, classification, and techniques anticipated
- Approximate time frame for the estimate to be performed

Some specific inputs to the Cost Estimating Process include:

- Mission Need Statement
- Critical Decisions
- Acquisition Strategy
- Project Execution Plan
- WBS
- COA
- Key Milestone Activities and Proposed Dates
- Functional Design Criteria
- Functional Performance Requirements
- Conceptual Design Report
- Preliminary Design
- Definitive Design

- Risk Management Plan
- Historical Info and Other Sources Of Information, Including Previous Cost Estimates
- Results of Alternative and Requirements Analyses
- Resource List and Labor Rates to Be Used
- Indirect/Overhead Rates to Be Used
- Assumptions
- Exclusions
- Construction and Operations Input

From this information, whether provided by others or developed by the estimator as an assumption, appropriate estimating techniques may be determined.

## **Section 3.1.2 - Cost Estimate Development**

This second step in the estimating process is the development of the cost estimate and its corresponding schedule and basis of estimate. It is important that scope development, documentation, and control be coordinated with the cost estimate production, since they are key iterative processes. Cost estimate production includes several steps, such as:

- Become familiar with a scope of work. Identify the project, subprojects, milestones, activities, and tasks
- Perform quantity-takeoffs and field walk-downs
- Obtain budgetary or contract-supplied vendor information or market research, or establish other pertinent sources of information
- Establish productivity rates or perform task analyses
- Calculate all applicable costs, including direct costs, indirect costs, contingency, and escalation (utilizing the schedule to calculate years for escalation)
- Produce all applicable detail and summary reports
- Establish a funding profile utilizing the WBS and/or COA and time-phasing from the schedule
- Determine what risks (and to what extent) should be mitigated with activities (or assumptions) in the cost estimate
- Consider other inputs, including schedule information, risk management plan, and peer reviews, as appropriate

All of this should be done considering and utilizing the requirements, purpose, classification, and chosen technique for the cost estimate. Ultimately, the cost estimate should be commensurate with the project size, complexity, and life-cycle stage.

#### Section 3.1.3 - Cost Estimate Documentation

A well-documented estimate will withstand scrutiny. If rigorous documentation and estimate procedures are followed, the credibility of a cost estimate increases. It is important to document all steps of the Cost Estimating Process. The particulars of performing a cost estimate may vary, depending on local historical perspectives, professional judgment, available resources, and specific DOE program/field office requirements. As a minimum, the following items should be considered as cost estimate documentation:

#### 1. Cost Estimate

A cost estimate should typically contain elements for direct costs, indirect costs, contingency, and escalation. Detailed and summary estimate information should be arranged by WBS and fiscal year, within the period of performance. Information should clearly include: quantities, production rates, total labor hours, labor categories, labor rates (typically including direct hourly labor rates, fringes, and labor burdens), total labor costs, material unit costs, total material costs, subcontract unit costs, subcontract total costs, and cost element (work package, activity, etc.) totals. These items should be included and commensurate with available technical scope.

The estimate should be able to be systematically replicated, checked, verified, or validated. Worksheets, calculations, and other pertinent documentation should be well organized. Documentation should contain the following:

- Distinction of Total Estimated (Capital) Costs (TEC)/Other Project Costs (OPC)/Total Project Costs (TPC) or Performance Baseline (PB)
- Description of cost estimate techniques, quantities, and applicable rates
- Sources of information, such as historical costs, industry standards, published price lists, cost databases, informal budgetary information, CERs, etc.
- Allowances, assumptions, and exclusions
- Start-up costs, operating costs, and other life-cycle costs, as appropriate
- Calculated contingency
- Calculated escalation
- Estimate history, or cost estimate log, if the cost estimate is a revision to an existing estimate or a change order estimate
- The name, signature, and/or initials of the preparer and reviewer of the cost estimate

#### 2. Basis of Estimate

The Basis of Estimate documents the estimate assumption, exclusions, and criteria used in producing the estimate and should include the following items:

- Cost estimate purpose and class
- WBS, including deliverables and scope of work
- COA
- Project/program requirements and milestones, including constraints, special conditions, regulatory drivers, applicable DOE Orders, and industry standards
- Description of assumptions and exclusions
- Backup data, including quantity takeoffs, calculations, commercial databases, historical data, CERs, quotes, and other general sources of information
- Basis of direct costs (e.g., industry standards and historical information)
- Basis of indirect costs (e.g., rates from a corporate perspective)
- Basis of escalation
- Basis of contingency, which may include or reference a Risk Analysis or Risk Management Plan

## 3. Schedule

A schedule should be included as a part of the cost estimate documentation. Scheduling is an iterative process to cost estimating, scope development, and risk management. A schedule should reflect activities in the cost estimate, but may also show milestones, deliverables, and relationships. Normally, schedules do not address productivity or sources of information or contain indirect and overhead costs (and activities).

Schedules are used to time-phase a cost estimate, with which to calculate escalation, and should be iterative, based on resource loading or other criteria. The direct relationship between the scope of work, the cost estimate, the schedule, and the project risks should be clear, concise, and easily understood by anyone reviewing the cost estimate documentation.

#### 4. Reconciliation

Reconciliation may be necessary to account for changes made between Critical Decisions or other life-cycle project milestones. Reconciliations should be organized by WBS and cover all aspects of project documentation (cost estimate, basis of estimate, schedule, and risks). In general, reconciliation should recognize or highlight specific changes in scope, basis of estimate, schedule, and risks. There should be an understanding that, as time progresses, more and better information is expected to be available and used as project or cost estimate documentation.

Reconciliations are necessary to mitigate budget shortfalls and may be used to correct deficiencies from internal or external reviews.

#### Section 3.2 - Cost Estimate Contents

Cost estimates are normally organized by a WBS, a COA, Work Packages/Planning Packages, and/or other standardized code structures (e.g., Masterformat, Uniformat II, ECES). Standard definitions of direct and indirect costs provide consistency in estimating costs and facilitate useful project reporting. This also benefits program/project

management reports, independent estimates (Government Estimates), reviews, contract/project validations, and cost/price analysis. These cost estimates are forecasts or plans of things to eventually be managed.

As work is authorized to proceed, these cost estimates become budgets. There is a distinction between budget allocations and cost estimates, budget is used to execute work. (Also see a later discussion on Management Reserve, which is budget placed on contract.)

Figure 3–2 depicts the contents of a Performance Baseline (PB). A PB consists of a projects' Total Project Cost (TPC), including various contract prices, non-contract costs, and contingency.

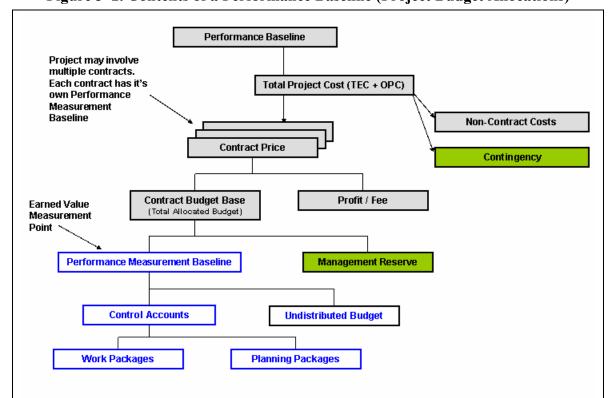


Figure 3-2. Contents of a Performance Baseline (Project Budget Allocations)

#### **Cost Estimate Content Organization**

A specific definition of items to be included as direct costs, indirect costs, and overhead costs should be included at the discretion of the DOE program offices and DOE field offices and/or determined by their contractor's financial system; however, the following is provided as guidance.

The point of defining these here is to assure that there is no accounting overlap between items estimated as direct, indirect, or overhead costs. Generally, cost estimate content includes:

Direct costs

- Indirect costs, including overhead and profit
- Contingency
- Escalation



Each activity in a project must be considered *either* a direct or an indirect cost; however, there should be no duplication or overlap. There should be a clear distinction between those activities that are directly and those that are indirectly related to a project.

Regardless of this distinction, a cost can be considered *either* direct or indirect. Depending on the situation, site, program, or project-specific requirements or procedures, a direct cost at one site or project may not be direct at another.

However, to the extent possible, this distinction should be consistently applied among projects, for a DOE program, or at a DOE site location.

#### ONE OR THE OTHER, BUT NOT BOTH!

Cost Estimates developed specifically to support budget formulation should include three specific categories of costs, as follows:

#### I. Design Phase

Preliminary and Final Design

Design Management

**Project Management** 

#### II. Execution Phase

Land and Land Rights

Improvements to Land

**Buildings** 

Special Equipment

Other Structures

**Utilities** 

Standard Equipment

Major Computer Items

Removal Cost Less Salvage Value

Inspection, Design, and Project Liaison

Testing, Checkout, and Acceptance

**Construction Management Cost** 

**Project Management** 

III. Contingency

Design Phase

**Execution Phase** 

More detailed information on these categories can be found in the excerpts of the "DOE Budget Formulation Guidance," in Appendix 6.6. DOE's *Budget Formulation Handbook* also includes definitions used in both DOE's budget formulation and project management, and examples of Project Data Sheets, used in submitting budgets.

*DOE Budget Formulation Handbook*, for FY 2005, may be found at: <a href="http://www.mbe.doe.gov/budget/guidance/fy2005/field/Handbook.pdf">http://www.mbe.doe.gov/budget/guidance/fy2005/field/Handbook.pdf</a>

#### **Section 3.2.1 - Direct Costs**

*Direct costs* include any costs that can be attributed solely to a particular project or activity, including labor, materials, subcontracts, equipment, salaries, and travel. Emphasis is placed on the term *activity*, which typically in standard practice equates to a lowest WBS element, COA element, work package, or planning package.

Items typically recognized as direct costs include, but are not limited to:

- Construction activities, including labor, materials, equipment, subcontract costs, premium pay, and productivity adjustments, such as those for contamination or security restrictions.
  - These activities include common construction activities, such as mobilization and de-mobilization, sitework, concrete work, masonry work, etc.
- Operations activities, also including labor, materials, equipment, subcontract
  costs, premium pay, and similar productivity adjustments, such as those for
  contamination or security restrictions.
  - These activities include common operations activities, such as routine planning, monitoring, reporting, and meetings regarding a program's mission; warehouse operations, operating facility operations, administrative activities, research and development activities related to a programs mission, collaboration, travel, training, etc., but also may include such things as establishing a project prior to having an approved mission need, establishing an estimate of required PED funds, some preliminary design between CD-0 and CD-1, tie-ins to existing infrastructure, and start-up costs.
- Maintenance activities, also including labor, materials, equipment, subcontract
  costs, premium pay, and similar productivity adjustments, such as those for
  contamination or security restrictions.
  - These activities include common maintenance activities, such as routine and preventative maintenance, minor facility repairs and/or upgrades, minor paving or landscaping, etc.
- Decontamination, decommissioning, dismantling, and demolition activities
- Project management activities

- Construction management activities
- Design, development, and start-up activities
- Security escorts and restrictions
- Special (capital) and standard (capital or non-capital) equipment
- Freight, packaging, and transportation
- Health physics support, radiological controls support, protective clothing/PPE, and industrial safety/health
- Sales and use taxes

Some items that may be included as direct costs as a part of a "loaded" labor rate include:

- Holiday and vacation pay
- Payroll taxes and insurance
- Other fringe benefits or labor burdens
- Contract fee/profit

#### Allowances

In planning projects, it is normal to include activities for which there is little or no design basis, especially in the earliest stages of a project. These activities may be included as allowances. These are *not* considered a contingency. Allowances should be included as appropriate, at the discretion of the PD, PM, and the IPT, to cover anticipated costs associated with a known technical requirement or activity.

For instance, in a Class 5 cost estimate (Order of Magnitude cost estimate), it would be appropriate to see a line item (cost account, or activity) such as "Utility relocation, 1 lot, \$1M material and \$1M labor," indicating some utilities that needed to be relocated as part of this project. There should be other documentation supporting these costs (such as approximate quantities, basis for those quantities, and source of the projected costs (e.g., "consensus of the project team") proportional to the significance and importance of the activity. Allowances may also be included in a project to cover costs associated with productivity adjustments, anticipated subcontract changes, anticipated design changes, or other similar elements of known scope and costs.

#### **Special Conditions**

Consideration must be given to all factors that affect a project or program. Some of these factors are:

- Availability of skilled and experienced manpower and its productivity
- The need for overtime work
- The anticipated weather conditions during the period of performance
- Work in congested areas or in radiation areas
- Security requirements imposed on the work area
- Use of respirators and special clothing

Special conditions may be estimated by applying a factor. For example, 10% applied to labor hours for loss of productivity due to work in a congested area. Other items may be calculated by performing a detailed takeoff. An example of this would be an activity that could only be performed over a two-day period. Overtime would be required to complete the activity and the number of hours and rates could be calculated.

#### **Design Costs**

To estimate Design (formerly ED&I) costs, the estimator must understand what activities are included in Design. The following is a list of Design-related activities:

- Preliminary and final design calculations and analyses
- Preliminary and final plans and drawings
- Outline specifications
- Construction cost estimates
- Computer-Aided Drafting (CAD) and computer services
- A/E internal design coordination
- Design cost and schedule analyses and control
- Design progress reporting
- Regulatory/code overview by A/E
- Procurement and construction specifications
- Surveys (surveying), topographic services, core borings, soil analyses, etc., to support design
- Travel to support design
- Reproduction during design
- Design kickoff meeting
- Constructability reviews

- Safety reviews by A/E
- Value engineering
- Identification of long lead procurements
- Design studies not included in Pre-Title I
- Preliminary safety analysis report if not included in the Conceptual Design Report
- Design change control
- Modification of existing safety analysis report
- Design reviews (not third party)
- Acceptance procedures
- Certified engineering reports
- Bid package preparation
- Bid evaluation/opening/award
- Inspection planning
- Inspection services
- Review shop drawings
- Preparation of as-built drawings

## **Considerations for Estimating Design Costs**

Design costs are directly related to the magnitude and complexity of the project. The following items should be considered.

## 1. Comprehensiveness of the Functional/Operational Requirements

Project understanding is improved when comprehensive functional/operational (F/O) requirements are provided. For the F/O requirements to be well done, each item must be thought through by those who review the design and will use, operate, and maintain the facility or system.

## 2. Quality Level

Quality level, as defined below, is significant particularly as it affects the analysis, documentation, and inspection required. Design costs are increased by the additional work that may be required by the following levels:

## a. Quality Level I

Applied to nuclear system, structure, subsystem, item, component, or design characteristics that prevent or mitigate the consequences of postulated accidents that could cause undue risks to the health and safety of the public

## b. Quality Level II

Any other system, structure, subsystem, item, or component that, as a result of failure, could cause degradation of required performance, such as plant operation, test results, and performance data

## c. Quality Level III

Items designated for minimal impact applications

## 3. Design Planning Tabulation

Design Planning Tabulation (DPT) sets forth a number of important items that affect Design costs. The DPT sets the code requirements the design will meet, reviews to be held, quality levels, and documents to be issued.

#### 4. Design Layout

Design layout costs are affected by the availability of existing documents and the accuracy of these documents. The need for an engineer to make detailed layouts, rather than having it done by draftsmen/designers, also affects cost.

#### 5. Engineering Calculations

The number and detail of calculations required is an important engineering cost factor. The need for review of these calculations by others and their documentation and storage can affect Design cost significantly.

#### 6. Drafting

The drawing format and the method of accomplishment of the work depicted (i.e., by maintenance, lump sum construction contract, or cost plus construction contract) will affect the detail and time required to prepare drawings. The type of drawing and the discipline of work are also big factors in time required. The number of drawings involved is a direct indication of drafting time and cost. The availability of standard details, etc., can reduce costs appreciably. Quality Level I or II requirements can also add to drafting requirements and thus to time.

## 7. Specification Preparation

The availability of draft specifications for the items of work involved or the need to develop new specifications must be considered. Projects requiring preliminary proposals require both an outline specification, which is normally prepared with Title I, and a detailed technical specification. Performance specifications for both the design and installation by a subcontractor of facilities and systems, such as fire protection, will reduce engineering costs. Design costs incurred by the subcontractor are classified as subcontract construction costs.

#### 8. Checking

The need for field investigation can be a significant engineering cost. If drafting must be checked by checkers within that section, the time must be considered and costs added. Projects requiring inter-discipline checks must have time/cost provisions. Checks made by engineers must also be considered.

## 9. Cost Estimating

Time required for estimating is affected by the detail of the project, particularly the number of items involved and the areas in which good information from historical data is available. Specialty items usually require additional effort and cost.

## 10. Design Reviews

The number of design reviews and action taken will affect costs. If the design is so formal that a committee is established for the review and the designers must present their designs step by step, the additional costs required for review must be included.

#### 11. Safety Analysis Report

When a Safety Analysis Report (SAR) is required, the engineering costs are contingent upon similar documents having been prepared previously or the requirements to develop new ones.

## 12. Reports

Engineering costs for preparing reports such as preliminary proposals, design status reports, etc., must be included in the Design funds.

## 13. Government Furnished Equipment

Engineering costs for providing documents required for procuring Government Furnished Equipment (GFE) items must be included. These costs include specifications. Time required for engineering is more than if the item had been included with the other technical documents due to document control and the need to include in the technical documents information on the item being furnished.

#### 14. Off-Site A/E

If an off-site A/E is to be used for the Design, travel costs for field investigation, Design reviews, and management of the Design should be considered. Cost is a percentage of construction cost. If changes are required, onsite A/E may have to make the changes, which could lead to problems in interpreting or understanding the basis of the original design.

## 15. Inspection

Included as part of Title III, all construction work, including procurement and installation of associated equipment, shall be conducted in all cases prior to acceptance. Inspection should be made at such times and places as may be necessary to provide the degree of assurance required to determine that the materials or services comply with contract and specification requirements, including quality level requirements. The type and extent of inspection needed will depend on the nature, value, and functional importance of the project and its component parts, as determined by project requester/proposer.

#### 16. Duration

Duration is the number of actual construction days anticipated for the project. Unforeseen conditions, such as delays in start-up and waiting for materials, are not included in this duration.

## 17. Labor Density

Labor density is the ratio of estimated costs of materials to costs of labor. In general, construction with a high labor density will require more inspection.

## 18. Complexity

A project having a high degree of instrumentation of a large amount of "code equivalent" welding will require more inspection per dollar of labor than will earth work or ordinary concrete work.

#### 19. Overtime

The time schedule of utility outages, reactor windows, and the overall project schedule may require overtime.

## 20. Adequacy of Plans and Specifications

If the technical package is clear, with a minimum of ambiguities and field changes, the inspection cost will be lower.

#### 21. Off-site Fabrications

Inspection costs will increase if source inspections are required. Supplies and services shall be inspected at the source where:

- a. Inspection at any other point would require uneconomical disassembly or nondestructive testing
- b. Considerable loss would result from the manufacture and shipment of unacceptable supplies or from the delay in making necessary corrections
- c. Special instruments, gauges, or facilities required for inspection are available only at source
- d. Inspection at any other point would destroy or require the replacement of costly special packing and packaging
- e. A quality control system is required by the contract, or inspection during performance of the contract is essential
- f. It is otherwise determined to be in the best interest of the Government

#### 22. Location of the Job

Travel time to and from the job must be taken into consideration.

#### 23. Guideline

Design costs have been 15%–26% of the total construction cost for detailed design.

#### 24. Performance Specification

This type of specification requires the subcontractor to supply the amount of detail required to complete the project. The amount of Design required for a performance specification is appreciably less than that required for the detailed design.

## **Engineering**

Although these services may seem similar to conventional engineering, design, and inspection, there are several important differences that distinguish cleanup design from engineering design on other projects. These differences need to be underscored when estimating cost and schedule requirements. Major factors to be considered by the estimator include the following:

1. The regulatory process requires rigorous examination of design alternatives prior to the start of cleanup design. This occurs during remedial investigation/feasibility studies under CERCLA to support a record of decision (ROD) or during corrective measure studies under RCRA to support issuance of a permit. Cleanup design executes a design based on the method identified in the ROD or permit. This often narrows the scope of preliminary design and reduces the cost and schedule requirements.

The estimator needs to assess the extent to which design development is required or allowed in cleanup design. In some cases, the ROD or permit will be very specific, as in the case of a disposal facility where all features, such as liner systems, as well as configuration, are fixed. In other cases, such as when treatment options like incineration are recommended, considerable design effort may be required.

2. Requirements for engineering during construction, including construction observation, design of temporary facilities, quality control, testing, and documentation, will often be higher than for conventional construction. This results from the need to conduct construction activities for environmental projects in compliance with rigid regulations governing health and safety, quality assurance, and other project requirements.

#### Construction Management Costs

A construction manager (CM) is responsible for construction activities. This responsibility includes subcontracting, purchasing, scheduling, and a limited amount of actual construction. Chapter 3 is intended as a guideline for determining whether cost elements should be included as project management, construction management, or project support, and should be followed by all DOE field offices and contractors. Generally, CM costs are approximately 5%–15% of the sum of the direct costs, indirect costs, and GFE, whose installation is under the direction of the CM

#### **Project Management**

The estimate for project management must consider the time element from start of preliminary design through completion of the construction for the project. Other factors to consider are the complexity of the project, the design group, the organization for which the project is to be performed, and the extent of procured items. Projects involving travel must also include those costs. Typically, project management costs range from 2%–5% of the total project cost.

## **Construction Coordination**

Construction coordination includes a field engineer. The field engineer should be involved in the review of the Title I and II documents, as well as the coordination of field construction. This function is generally estimated to be about .5%–1% of the construction costs.

## **Quality Engineering**

For the quality engineering estimate, the tasks for the project must be defined, and the man-hour effort with the quality organizations should be negotiated. The estimate will depend upon the quality level of the project, the amount of procurement effort, and the level of involvement of the quality inspection organization. Where the latter is involved, quality engineering is responsible for the preparation of the quality plan. Travel must also be considered. The portion of quality engineering that is an audit function is not funded by construction and needs not be included in the estimate.

## **Health and Safety**

This function is involved with the review and approval of the Design package as well as the safety audits and health physics surveillance throughout the course of the construction period. Factors affecting this element are the type of project, the operational area where the construction takes place, the amount of work requiring radiation surveillance, and any other special health and safety requirements. The portion of health safety that is an audit function is not funded by construction and need not be included in the estimate. This is typically estimated by taking from .5% to 1% of the total construction costs for conventional projects and would be more than that for a remediation job.

#### Program Management

Activity management associated with environmental restoration parallels construction project management. However, when estimating activity management, consideration must also be given to program management. Program management consists of those services provided to the DOE on a specific program for planning, organizing, directing, controlling, budgeting, and reporting on the program. Program management will be provided as multiple levels within the EM program, including the Headquarters, Operations Office, and installation.

Program management includes program support. Program support covers those activities performed for internal management and technical support of the program by part-time or full-time personnel.

## Research and Development Costs

Traditionally, cost estimating has involved the compilation of historical data for use in correlating and validating existing estimating methodologies. These methodologies and the corresponding cost data are then used to prepare cost estimates. Historical data lends a cost estimate some accuracy and credibility. In today's environment, a problem arises when the cost estimate is required for new, innovative, "state-of-the-art," first/one-of-a-kind projects.

According to one author: "For many new ventures economic feasibility is dependent on process innovations as yet untried and unproven, and the technical alternatives are numerous and complex. In these cases, technical feasibility must be established and, depending on the size of the project, detailed systems design and planning may be needed to ensure accurate cost estimates."

Knowledge of the processes involved will help the cost estimator in preparing an accurate cost estimate. In the absence of accurate cost information, process knowledge can focus the estimator toward those parts of the project that are significant contributors to overall project cost.

#### A. Personnel Costs

Personnel costs are usually the largest R&D expense. R&D personnel are well educated and a have a higher pay scale than employees for conventional projects.

## B. Equipment Costs

Equipment costs for R&D projects can be divided into hardware and software costs. Hardware includes machinery, computers, and other technical equipment. Equipment costs increase with increasing project complexity. For example, if the research involves extensive modeling or computer calculations, a supercomputer may be required. Specialized software may have to be developed for the project, so software costs can also be significant contributors to the overall project cost.

## C. Prototypes and Pilot Plants

In some instances it will be cost effective to develop a prototype or a pilot plant for an R&D project. A cost estimate for a prototype or a pilot plant will have to account for the following:

- Construction of the equipment or plant
- Operation of the equipment
- Development of test criteria for plant studies
- Analysis of test results
- Computer simulation of plant processes

The estimate will also have to provide for project management and personnel during the pilot plant study or prototype testing.

#### D. Scaled Models

Plastic, scaled models of industrial facilities are used to improve visualization of

the facility in three dimensions. Building the model can identify problems that may occur during actual construction of the facility. Models can also be used as a management tool if the model is constructed as the facility is constructed. The model then shows the status of the project.

Models have many advantages, but the main disadvantage is cost, the models are expensive to construct. However, in most cases the benefits obtained from the model exceed the model's cost.

## E. Computerized Models

Computerized modeling may need to be performed for some projects. For example, if the project goal is to construct a new incinerator for mixed hazardous and radioactive waste, site-specific air dispersion modeling may be required to demonstrate that emissions from the incinerator will not have an adverse impact on public health or the environment.

Groundwater modeling may be required for some remediation sites. Assume the groundwater contamination has been found at a site, and several technologies are being proposed for the site. Modeling can be used to select the best technology or to determine the optimum locations for pumping or injections wells. Computer models have also been used to develop risk assessments for contaminated sites.

Finally, for conventional projects, finite element analysis may be used to determine potential weaknesses in a design. Some models can be quite complex and require specialized technical expertise on the part of the modeler to avoid the "garbage in = garbage out" phenomena. The labor hours required for input-data gathering, modeling time, labor and computer, and report preparation must be accounted for in the cost estimate.

#### **Regulatory Costs**

There are certain environmental and health and safety regulatory compliance costs associated with all facilities and projects.

For conventional government projects, the facility must satisfy all federal, state, and local waste disposal, wastewater effluent disposal, and air emission limitations imposed by the applicable agencies. Regulations are even stricter for facilities that process or store radioactive materials. Construction sites must follow Occupational Safety and Health Administration rules.

Environmental projects must protect human health and the environment during all phases of the project. Cost estimates must contain sufficient provisions for environmental and health and safety compliance. A familiarity with applicable regulations is required so a plan may be developed and the project will comply with those regulations.

#### A. Environmental Compliance Costs

The number and requirements of environmental regulations have increased dramatically in the past 20 years. Several items should be considered when preparing environmental compliance cost estimates:

- Type of project
- Project location
- Waste generation, effluent characteristics, and air emissions from the project

Project location is significant to the project cost. If the project will disturb a wetlands area or if the project is located in an extremely environmentally conscious state, such as California, the estimator should account for increased environmental compliance costs in the project estimate. The project will be more expensive to complete and operate under these special conditions.

Estimators are strongly advised to discuss the project with knowledgeable design staff and to contact personnel familiar with the environmental regulations that will affect the project. A knowledge of wastes generated or air emissions during the project will facilitate the identification of environmental compliance design requirements and subsequent costs. For example, wastewater treatment may be required prior to effluent discharge into a stream or publicly owned treatment works. Air pollution control devices may be required for process equipment. To estimate regulatory costs, an understanding of the types of costs that can be expected is needed. For example, permitting costs could include:

- Labor to gather data
- Equipment for testing
- Analytical tests
- Time for interface with project personnel and outside consultant, if applicable
- Permit fee
- Annual permitting costs
- Upgrades to existing equipment
- New pollution control equipment

Once a plan for regulatory compliance has been established, the regulatory costs can be estimated for that plan. This will establish a baseline for the costs, and regulatory changes that affect this baseline can be tracked and estimated throughout the project's life.

## B. Health and Safety Compliance Costs

Employee health and safety regulations have followed the same general trends as environmental regulations toward increased regulation. As allowable worker exposure limits decrease, design cost estimates will have to account for specific engineering controls to minimize employee exposures to toxic or hazardous substances in the workplace, especially for facilities involved with radioactive materials.

Past experience with "increased regulatory rigor" within DOE has shown that the costs associated with employee workspace controls, including industrial hygiene

monitoring, is the most significant cost factor in a more rigorous health and safety program. This trend will continue. Planning is essential since retrofit costs can exceed original installment costs. State-of-the-art, high-tech facilities may require additional initial employee exposure monitoring if unknown situations are encountered. Protective equipment must also be supplied and maintained for the employee. Environmental projects may have strict health and safety requirements, including routine medical surveillance, preparation of health and safety plans, and employee training. Employees may not be able to work eight hours a day if daily decontamination of personnel and equipment is mandatory.

## C. Compliance Costs and Scheduling

For some projects, a permit is required before the project can commence. For example, construction projects that will disturb more than five acres are required to obtain a storm water permit prior to commencing construction. Project scheduling can be affected if operating permits are not received in a timely manner. Facilities may be shut down for violations of operating permits or failure to comply with existing regulations. The time required for regulatory review of the permit application must also be factored into the cost estimate.

## **Specialty Equipment Costs**

Specialty equipment includes non-typical hardware or equipment, such as glove boxes for radioactive handling, or architectural specifications, such as computer room floors or flag poles. None of these examples are common to conventional projects; however, in most cases, a good cost estimate can be developed with the help of vendor quotes.

Computerized modeling may be required as part of the permit process, and any cost estimate for the project should include consideration for an outside consultant's modeling and report preparation costs.

#### **Non-Contract Costs**

Other DOE-direct costs should be included, as appropriate. Where activities and productivity for operations are concerned, costs should be calculated appropriately. Although Level-of-Effort cost estimates are normal (based on FTEs per year, etc.), it is still appropriate to consider activities and productivity. These costs are not automatically recognized by a contractor as pertinent, but should be included to portray a Total Project Cost (TPC), Performance Baseline (PB), or a project's total life-cycle costs, as appropriate.

## **Section 3.2.2 - Indirect Costs**

*Indirect costs* are incurred by an organization for common or joint objectives that cannot be specifically identified with a particular activity or project. Depending on the contract types and circumstances, these indirect costs may include programmatic or functional costs, such as comprehensive planning, security, procurement, engineering, project controls, cost estimating, or research and development. They may also include a contract's General and Administrative costs, or G&A.

Items typically included as site indirect costs are:

- Facilities, operating equipment, small tools, and general maintenance
- Temporary facilities (e.g., water, compressed air, and power)
- Motor pool, camp, and aircraft operations
- Warehousing, transfer, and relocation
- Safety, medical, and first aid
- Security
- Administration, accounting, procurement, and legal
- Personnel expenses, office supplies, and time reporting
- Permits and licenses
- Contributions to Welfare plans and signup/termination pay
- Contract fee/profit, bonds costs (performance and material payment)

A summary of Site Indirect Costs may be found at the FMSIC website: <a href="http://www.mbe.doe.gov/progliaison/fcstrpt/FY01fscr.pdf">http://www.mbe.doe.gov/progliaison/fcstrpt/FY01fscr.pdf</a>

## Section 3.2.3 - Contingency and Management Reserve

The purpose of this "Contingency and Management Reserve" description is to improve the understanding of calculating, documenting, and using contingency (DOE-held contingency) and management reserve (MR) in the project management process.

**Contingency** - an amount derived from a structured evaluation of identified risks to cover a likely future event or condition arising from presently known or unknown causes within a defined project scope. Contingency is controlled by the government.

**Management Reserve -** an amount of the total <u>allocated budget</u> withheld for management control purposes. Management Reserve is controlled by the contractor.

The application of contingency for various classifications of cost estimates covers the entire life cycle of a project, from feasibility through execution, operations, and ultimate disposition. Generally, as the design of a project develops, progresses to construction, and nears completion, the need for contingency decreases. The concepts of contingency may be generically applied to the technical scope (assumptions of risk), cost, and schedule aspects of any project.

## Contingency should ensure successful project completion!



- Contingency should be considered a normal element of a project.
- Contingency should be included, commensurate with project risks and uncertainty, primarily to assure successful project completion.
- Management Reserve is not calculated separately, but is allocated budget to be used by a project for management control purposes.

Figure 3–3 is taken from the *DOE Project Management Manual*. Considering that this shows budget allocation for a project, note that management reserve is (as defined) allotted budget within a contractor's control.

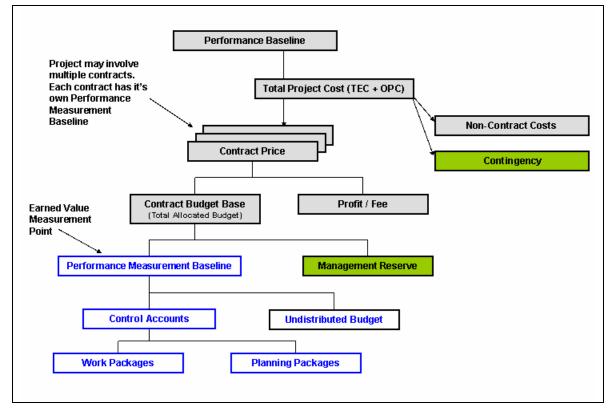


Figure 3–3. Contents of a Performance Baseline (Project Budget Allocations)

## Consider the following:

- PB = TPC (term used prior to CD-2)
- PB = Contract Price(s) + Non-Contract Costs + Contingency
- Contract Price = CBB + Profit or Fee
- CBB = PMB + MR
- PMB = Control Accounts + UB
- Control Accounts = Work Packages + Planning Packages
- Work Packages = Direct Costs + Indirect Costs (for current year work)
- Planning Packages = Direct Costs + Indirect Costs (including escalation for outyear work)

#### Where:

- PB is the Performance Baseline (the TPC after CD-2 Baseline Approval)
- TPC is the Total Project Cost (the PB prior to CD-2 Baseline Approval)
- CBB is the Contract Budget Base
- MR is Management Reserve
- UB is Undistributed Budget

Contingency is calculated as the cost estimate is being developed, based on risks, etc. However, MR is allocated budget, to be used for management and control purposes, that is, it may be negotiated and used as necessary. Therefore, there is normally only one contingency calculated for a project, and it may be later held by DOE as contingency and/or by a contractor as MR.

Contingency (DOE-held contingency) is an integral part of project TPC or PB. The amount of contingency should be commensurate with the maturity of the project, project/program size, and project risks, including technical uncertainties. Figure 3–4 depicts the contingency as a function of project life.

Contingency and its use should be tightly controlled by DOE. However, DOE should also consider the use of a MR by its contractors to 'stretch,' encourage production, or otherwise induce the IPT. The purpose of contingency and budget allocated as MR is to offset expected changes that occur in normal project execution. Contingency and MR are expected to be expended as necessary to maintain project TPC (PB); however, if variance exceeds thresholds and cannot be corrected using all available contingency and MR, a *deviation* occurs.

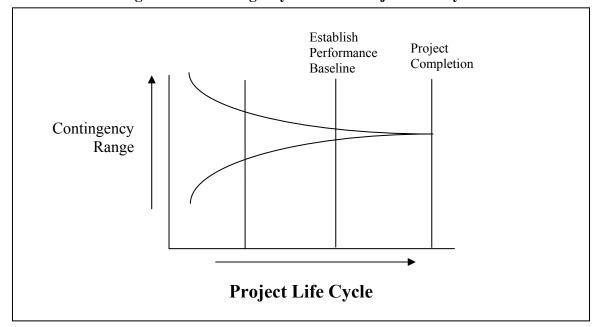


Figure 3–4. Contingency Over the Project Life Cycle

Contingency can be calculated using one of two approaches: Deterministic or Probabilistic. Either method may be employed to manage a project's risks:

- Deterministic Approach Where percentages are selected based on the degree of risks and uncertainty for several common types of projects and situations, usually from a table, and performed normally during the early stages of project development.
- **Probabilistic Approach** Uses statistical simulation (Monte Carlo simulation, range estimating, etc.) and generic steps in calculating appropriate amounts of contingency, normally during the later stages of project development as more definitive information is available.

Examples of the calculation of contingency may be found in Section 6.

## The Deterministic Approach

Unforeseen, uncertain, and unpredictable conditions will exist. Some considerations that affect the selection within those ranges may be:

- State-of-the-art design
- Security
- Required reliability
- Contamination, environmental conditions (weather, terrain, location)
- Equipment complexity

- Scheduling
- Construction restraints due to continuity of operation
- Other items unique to the project, such as nuclear and waste management permits and reviews

The *Deterministic Approach* to calculating contingency is simply an approximation, based on project complexity, degree of scope definition, or some other pre-defined parameter. The cost estimate *class* is also a primary determining factor.

Parts of the estimate may have different degrees of design completion, and appropriate contingency percentages may be used from Table 3–1 through Table 3–3, depicting contingency, based on:

- Project complexity
- Estimate class
- Type of work

The following tables are not intended to be a panacea or to replace rigorous risk planning and management. However, these tables can be used with care to ensure appropriateness of contingency included in any project.

Table 3–1. Contingency by Project Complexity

Type of Project	Contingency
Land and Land Rights	5% to 10%
Improvements to Land/Standard Equipment	10% to 15%
New Buildings and Additions, Utilities, Other	15% to 20%
Structures	15% to 20%
Engineering	15% to 25%
Building Modifications	15% to 25%
Special Facilities (Standard)	20% to 30%
Experimental/Special Conditions	Up to 50%

Table 3–2. Contingency by Class of Estimate

Class of Cost Estimate	Contingency
Class 5 - Order of Magnitude	
Standard	20% to 30%
Experimental/Special Conditions	Up to 50%
Class 3 - Preliminary	
Standard	15% to 25%
Experimental/Special Conditions	Up to 40%
Class 1 - Definitive	5% to 15%

Table 3–3. Contingency by Type of Work

Type of Work	Contingency
ENGINEERING	
Class 5 – Order of Magnitude and Class 3 - Preliminary	15% to 25%
Class 1 - Definitive	10%
EQUIPMENT PROCUREMENT	
Before bid	
Class 5 - Order of Magnitude	15% to 25%
Class 3 - Preliminary	10% to 20%
Class 1 - Definitive	5% to 15%
After award	
Cost Reimbursable Contracts	15%
Fixed-Price Contracts	1% to 5%
After delivery to site (if no rework)	0%
CONSTRUCTION	
Prior to award	
Class 5 - Order of Magnitude	15% to 25%
Class 3 - Preliminary	10% to 20%
Class 1 - Definitive	5% to 15%
After award	
Cost-Reimbursable Contracts	15% to 20%
Fixed-Price Contracts	3% to 8%

## The Probabilistic Approach

A *Probabilistic Approach* may be used in calculating contingency. This approach is normally more appropriate for larger, more complex projects. In using a Probabilistic Approach, you must first understand the statistical concept of probability. Probability is the degree of certainty or the likelihood that something will happen. Probability is normally expressed as a percentage. For instance, a 99% probability means that something is very likely to occur.

Generic steps using the *Probabilistic Approach* to calculating contingency:

- Step 1 Determine Base-Cost Estimate.
- Step 2 Determine risks associated with each WBS element, Control Account, work package, or planning package.
- Step 3 Determine best, expected, and worst-case cost scenarios for each WBS element, Control Account, work package, or planning package.
- Step 4 Run Monte Carlo simulation.
- Step 5 Determine contingency.
- Step 6 Total cost estimate, including contingency

As a budget is established (using the cost estimate information), accounts are established for the Performance Baseline (total budget for the projects TPC), Contract Prices, non-contract costs, and contingency. Other accounts are established within contracts for management and control purposes, including the Contract Budget Base, Profit/Fee, and Management Reserve.



- There are various ways to identify risks, establish probabilities, and calculate contingency (including the use of various software).
- Policy regarding the calculation and management of contingency should be established within a program or field office for consistency and standardization. However, there is no DOE policy regarding percentages to be used or specific confidence levels to be obtained in order to manage successful projects.

#### **Programmatic Risks**

It is not DOE practice to set aside contingency for major schedule changes or unknown design factors, unanticipated regulatory standards or changes, additions to project scope definition (changes outside a project's intended scope), force majeure situations, or program budget reductions. These may be considered *programmatic risks*, which are applicable to all projects within their respective programs. *Programmatic risks* should be addressed consistently among projects, but generally should not be included to offset a worst-case-scenario!

#### **Buried Contingency**

Typically, it is <u>not</u> sound business or professional practice to overstate anticipated costs, or to *bury contingency*. Excess estimates of costs should always be avoided, it is better to have a sound basis for costs that are included than to bury contingency.

All estimators should refrain from burying contingency or unnecessary allowances within

an estimate. A culture of honesty should be promoted so it is not necessary to bury contingency. Estimators should be aware that reviews may identify buried contingency, and known buried contingency should be removed!

Buried contingency has been identified in many ways, including:

- Unjustified increase in quantities, affecting materials, labor, and equipment costs
- Unjustified increase in crew sizes or necessary Full-Time Equivalent personnel (FTEs), affecting labor rates and total labor costs
- Unjustified decrease in productivity anticipated, affecting labor and equipment hours and costs
- Unjustified increase in accounting for waste and scrap, affecting labor and material costs

## **Contingency Analysis/Risk Analysis**

A *Contingency Analysis* is a written explanation of how contingency was calculated, along with a summary of the contingency costs that are calculated. Considerable latitude has been reserved for estimators and managers in performing contingency analysis. However, a written contingency analysis should be performed on all cost estimates and maintained in the estimate documentation file or basis of estimate.

Ranges for contingency are provided in Table 3–1 through Table 3–3 for reference. However, if contingency included in a cost estimate does not clearly fall within those ranges, justification should be provided. If extraordinary conditions exist that call for higher contingencies, the rationale and basis should be documented. Computer programs may be used to develop contingency factors. A risk analysis may be used to support the contingency analysis.



 As a project progresses and subsequent cost estimates are performed, contingency ranges and amounts should decrease.

#### **Section 3.2.4 - Escalation**

Costs continuously change due to three factors:

- 1) Change in technology
- 2) Change in availability of resources
- 3) Change in value of money (e.g., inflation)

Historical cost indices and forecasted escalation indices have been developed to document and forecast changing costs. The use of an established escalation index is

required to consistently forecast future project costs. To ensure proper usage of an index, one must understand its bases and method of development.

Escalation is the provision in a cost estimate for increases in the cost of equipment, material, labor, etc., due to continuing price changes over time. Escalation may be (1) forecasted, to estimate the future cost of a project based on current year costs or (2) historical, to convert a known historical cost to the present. Most cost estimating is done in current dollars and then escalated to the time when the project will be completed, although the forecasted and historical escalation rates may be used in succession. This section discusses the use and application (calculation) of escalation and historical cost indices. An example of the calculation and use of escalation can be found in Chapter 8.

## **Forecasted Escalation Rates**

Forecast escalation rates are obtained from commercial forecasting services, such as Global Insight (formerly DRI-WEFA), which supplies its most current predictions using an econometric model of the United States economy. The forecasted escalation index is the ratio of the future value to the current value expressed as a decimal.

Forecast escalation rates are simply the percentage change from one year to the next, typically prepared for various groups, utilizing different sources of data. For example, the forecast escalation indices for construction may contrast with the one for environmental restoration, because the "market basket-of-goods" is so different. Annual escalation rates are recommended by OECM, through the annual Budget Formulation Guidance, to the DOE program offices and DOE field offices.

Because the duration of larger projects extends over several years, it is necessary to have a method of predicting the funds that must be made available in the future to pay for the work. This is where forecasted escalation rates are used. The current year cost estimate is divided into components and then multiplied by the appropriate forecast escalation rate to produce an estimate of the future cost of the component. The future costs of these components are then summed to give the total cost of the project.

To properly apply escalation, the following data is required:

- Reference date the estimate was prepared and base date of costs
- Escalation index, or cumulative rates, to be used (including issue date and index)
- Schedule, with start and completion dates of scheduled activities

Escalation should be applied for the period from the date the estimate was prepared to the midpoint of the performance schedule or the activity being escalated. There are many more detailed methods of calculating escalation, but care should be taken to not make this calculation too complex, remember, someone external to the project may need to review this calculation. Regardless of the method used, the process should be well-documented.

"Which comes first, contingency or escalation?" If a project includes a contingency that is based on risks, and those risks have associated costs, this may imply use of the same base year dollars. And generally, performance periods can be associated with those risks within components, so, escalation may be applied to contingency. However, if contingency is not easily discernable by WBS element or cannot be associated with a

time period, it may not be appropriate to escalate contingency. <u>The cost estimate should</u> ultimately represent total escalated costs!



- Several different methods may be used to calculate escalation, including the use of a specific project spending curve.
- Escalation should be included at a level appropriate for the size and complexity of the project.

#### **Historical Escalation**

Historical escalation is generally easily evaluated. For example, the cost of concrete changed between 1981 and 2002. The ratio of the two costs expressed as a percentage is the historical escalation rate, or expressed as a decimal number is the historical cost index. Several commercially available Historical Cost Indices are available.

To properly apply a historical cost index to make price more current, the following data is required:

- The prior cost or price, with a reference date, such as an actual price for a known project or a component. This cost or price may include direct material and/or labor cost, and it should be known to what extent indirect costs (sales taxes, freight, labor burden, etc.), overheads, and profit were included
- An applicable historical cost index

Current escalation rates may be found at the DOE-CEG website, or in the current years' DOE Budget Formulation Handbook. When rates used are other than those provided as guidance, supporting documentation should be provided or referenced in the basis of estimate. More specific guidance regarding the use and application of escalation may be provided by the DOE program or field office. Table 3–4 contains the current DOE Escalation Rate Table.

**Project Categories** FY Construction EM IT R&D O&M 2002 1.000 N/A 1.000 N/A 1.000 N/A 1.000 N/A 1.000 N/A 2003 1.021 2.1 1.020 2.0 1.008 8.0 1.018 1.8 1.023 2.3 2004 1.046 2.5 1.047 2.7 1.017 0.9 1.045 2.6 1.051 2.8 2005 2.9 2.7 1.073 2.7 2.7 1.076 1.075 1.022 0.5 1.080 2006 1.106 2.8 1.103 2.6 1.032 1.0 1.101 2.6 1.108 2.6 2007 1.135 2.6 1.130 2.4 1.041 0.8 1.127 2.4 1.136 2.5 2008 1.164 2.6 1.157 2.4 1.049 0.8 1.154 2.4 1.164 2.5

Table 3–4. Escalation Rate Assumptions for DOE Projects (January 2003)

This table can be found at:

http://oecm.energy.gov/cost\_estimating/2003%20Esc%20Rates.pdf

or in DOE Field Budget Call, page D-3, at:

http://www.mbe.doe.gov/budget/guidance/fy2005/field/Call.pdf

## **Discount Rates**

Where escalation rates are to account for estimated increases in material and labor prices, discount rates are to be used to account for the time-value-of-money and should be used in analyses to calculate Net-Present-Values (NPV). OMB provides discount rates for federal agencies to use in various types of analysis (see Section 4.3). OMB A-94 provides useful information on Real and Nominal Discount Rates and their application.

OMB Discount Rates can be found at:

http://www.whitehouse.gov/omb/circulars/a094/a94 appx-c.html

#### Section 3.3 - Reviews

The third step in the Cost Estimating Process consists of reviewing the cost estimate for quality aspects prior to its final intended use. These should be used as a means of assuring cost estimate quality. There are at least four types of reviews: Design and Constructability Reviews; Peer Reviews, which include reviews of the estimating department or project team; Internal Reviews, where "Internal" means internal to a DOE project, program, or DOE field/site office; and External Reviews, where "External" means external to a DOE project, program, or DOE field/site office and where findings are addressed formally and corrections are made as formal corrective actions.

There are two primary methods of review: objective and subjective.

Objective reviews normally consist of a very structured approach, such as a checklist with some type of grading system, which addresses consistency about

projects estimated or procedures followed. Objective reviews may also indicate a minimum acceptable level of quality.

Subjective reviews are normally less structured and may address areas differently, depending on various levels of emphasis. Internal reviews may be a combination of objective and subjective criteria, but should be performed consistently between projects within a program to the most practical extent.

As a minimum, *all* estimate reviews should address the Review Criteria depicted in Appendix 6.5.

## **Section 3.3.1 - Design and Constructability Reviews**

Design and Constructability Reviews are essential in capturing all activities and resources required to complete a project successfully. Each DOE field or site office should ensure that projects are designed efficiently and effectively, and that when design is complete, the project can actually be built or executed as designed! These reviews are also valuable in establishing risks to be encountered, which normally need to be addressed in a project's Risk Management Plan.

#### Section 3.3.2 - Peer Reviews

Peer Reviews are cost estimate reviews conducted internally within a department or DOE contractor prior to submission to DOE for review or official use. Peer Reviews may be objective or subjective, may be formal or informal, and may be written or oral, but generally, especially on more complex projects, should be documented. As the name implies, Peer Reviews are performed by cost estimating peers or those that work with the cost estimators. This can consist of a project team, a design group, a cost estimating department or manager, or an array of individuals that can provide necessary feedback to the cost estimator prior to releasing a cost estimate. These reviews should ready the cost estimate for further scrutiny.

#### **Section 3.3.3 - Internal Reviews**

Internal Reviews are cost estimate reviews, conducted internally within a DOE project, program, or site or field office. These reviews may sometimes be referred to as Independent Project Reviews (IPRs, instigated by a DOE program office) or Reasonableness Reviews (initiated by a DOE site or field office, DOE Budget Validations fall into this category). Generally, Internal Reviews are well-documented and can be a good source of fact-finding for other (including external) reviews.

#### **Section 3.3.4 - External Reviews**

External Reviews are not so much a step in the Cost Estimating Process as they are a project responsibility. This includes reviews conducted outside the cognizance of the party responsible for the cost estimate (DOE program or field office). This is also a quality assessment which may be performed to answer questions from Congress and other interests outside the responsible DOE program. Generally, these external reviews are a part of this cost estimating guidance because (per LCAM and DOE O 413.3) it is a DOE field program, site and field office, and contractor responsibility to coordinate and facilitate these reviews. Specifically, External Independent Reviews (EIRs) are those project reviews mandated by Congress on specific projects. An EIR guide is available

## from OECM.

Similar to internal reviews, the external reviews may consist of both objective reviews (utilizing checklists or other specific criteria) and subjective reviews (informal criteria). Criteria used for these external reviews are based on the types of information, the purpose, and the time available. Because there are various reviewers, purposes, and types of projects to be reviewed, each review is normally specific to a project or program.

More information on External independent Reviews may be found at: <a href="http://oecm.energy.gov/project-reviews/OECMIndepReviewProcedure05-14-01.pdf">http://oecm.energy.gov/project-reviews/OECMIndepReviewProcedure05-14-01.pdf</a>

# **CHAPTER 4 - COST ESTIMATING OUTPUTS**

SECTION 4.1 - COST ESTIMATE INTERFACES

SECTION 4.2 - BASELINES AND CHANGE CONTROL

SECTION 4.3 - ANALYSIS

SECTION 4.4 - VALUE ENGINEERING

**SECTION 4.5 - ESTIMATES AT COMPLETION** 

SECTION 4.6 - FINAL PROJECT COST REPORT

CHAPTER 4 - COST ESTIMATING OUTPUTS will discuss the outputs of the Cost Estimating Process, as depicted in Figure 4–1. In many cases, these are specifically defined cost estimates, for instance the Critical Decision Process. But otherwise, outputs include the traditional change control process, economic and cost-benefit analysis, value engineering, earned value, and final project cost reports.

Some terms use in this chapter and defined in Chapter 7 include:

- Baseline
- Change control
- Analysis
- Value engineering
- Estimates at completion

Schedule Risk Management Plan

Peer Reviews Of Work

Figure 4–1. Cost Estimating Process

## **Section 4.1 - Cost Estimate Interfaces**

Cost Estimate development is initiated into a process through inputs to the process. These inputs are either one-time or iterative. One-time inputs may include (but are not limited

to) the Project Charter, Project Execution Plan, Acquisition Strategy, and Acquisition Plan. All of these are inputs to the Cost Estimating Process, but they will not necessarily evolve through the Cost Estimating Process.

Other inputs may evolve through the Cost Estimating Process, such as the Risk Assessment (primarily risk identification), schedule, and scope development. Peer reviews, too, are iterative. Input to or by cost estimating peers may impact the quality of the cost estimate, and peer reviews should be required before external reviews are conducted.

## **Section 4.2 - Baselines and Change Control**

Cost estimates are normally organized by a WBS, a COA, and/or some other standardized definition (e.g., CSI Divisions). Standard definitions of direct and indirect costs provide consistency in estimating costs and project reporting. This also benefits program/project management, independent estimates (Government Estimates), reviews, and contract/project validations and cost/price analysis. Figure 4–2 depicts the contents of a Performance Baseline (PB). A PB consists of a projects' Total Project Cost (TPC), including various contract prices, non-contract costs, and contingency.

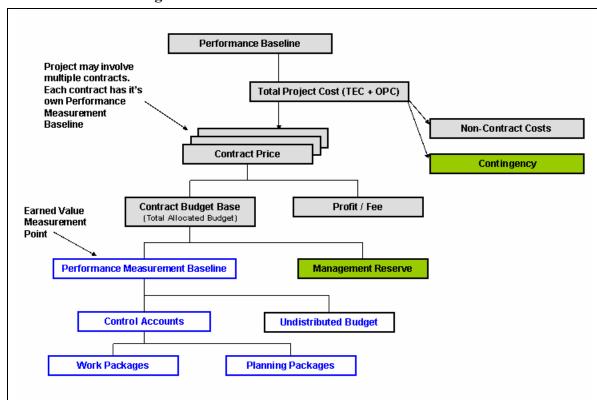


Figure 4-2. Contents of a Performance Baseline

As projects evolve, they become "baselined" and changes are managed against those baselines. Cost estimates supporting proposed or directed changes should contain the

same level of quality as the primary baseline cost estimate.

Baselines are expected to remain intact throughout the remainder of the project (from CD-2). Changes are expected, but should remain within the Performance Baseline (PB). If a project encounters a situation where the PB is breached, the project is said to have a *deviation*. When projects expect a deviation, they are required to assess corrective actions and establish a plan for correction or obtaining approval, similar to other previous critical decisions.

## **Section 4.3 - Analysis**

Analysis implies breaking a cost estimate into components for investigation. In many cases, analysis will provide insight to a decision-maker. Such is the case of cost-benefit analysis, required by OMB. Cost-benefit analysis is required for all acquisitions in the government, if a project's costs exceed its benefits (quantitative and qualitative), the government probably shouldn't be doing it. In some cases, analysis is in the hands of a reviewer to assert the feasibility or efficacy of a project.

In the contracting community, cost analysis or price analysis is a comparison of either costs or price, respectively (e.g., a proposal to a government estimate). If a contract is competitively bid, cost analysis (which is more detailed and complex than price analysis) may not be required.

However, many analyses are performed in the life of a project. Some related terms, sometimes used synonymously, are:

- *Cost-benefit analysis* the systematic, quantitative method of assessing the desirability of government projects or policies when it is important to take a long view of future effects and a broad view of possible side-effects.
- Cost-effective analysis appropriate when it is unnecessary or impractical to consider the dollar value of the benefits provided by the alternatives under consideration. This is the case when (1) each alternative has the same annual benefits expressed in monetary terms or (2) each alternative has the same annual effects, but dollar values cannot be assigned to their benefits.

  Analysis of alternative defense systems often falls in this category. Cost-effective analysis can also be used to compare projects with identical costs but differing benefits. In this case, the decision criterion is the discounted present value of benefits. The alternative program with the largest benefits would normally be favored.
- *Economic analysis* considers all costs and benefits (or expenses and revenues) of a project, considering various economic assumptions made, such as inflation and discount rates.
- Life cycle cost analysis considers all costs (capital, operating, and decommissioning expenses for the duration of a project) for various alternative approaches, including inflation and discount rates.
- Sensitivity analysis considers all activities associated with one cost estimate. If a cost estimate can be sorted by total activity cost, unit cost, or quantity, sensitivity

analyses can determine which activities are "cost drivers" to answer the question, "If something varies, what most affects the total cost of the project?"

- *Uncertainty analysis* considers all activities associated with one cost estimate and their associated risks. An uncertainty analysis may also be considered part of a risk analysis or risk assessment.
- Other types of analysis are performed throughout the life of most projects. Some analyses are highly structured and formal, while others are loosely structured and informal. Analyses supporting critical decisions should be structured and formal; that is, well-documented.

Normally, analyses require using similar cost estimate structures (separate cost estimates for each alternative considered); having all costs for all alternatives depicted as either present worth or annuities; and comparing alternatives using net present value or annuities. Normally a written summary of the findings is also prepared to explain the analysis.

## **Section 4.4 - Value Engineering**

DOE's Value Engineering (VE) program requires the use of cost estimates in doing VE studies. These are typically well-documented and structured for easy evaluation. VE studies come in many forms. Generally, when alternatives from a baseline are considered, they go through a screening process or evaluation to determine feasibility or reasonableness. The cost savings that result from VE studies should be reported, formally, through DOE's VE program.

More information on DOE's VE program may be found here: <a href="http://www.value-engineering.doe.gov">http://www.value-engineering.doe.gov</a>

# **Section 4.5 - Estimates at Completion**

There are several methods of determining Estimates at Completion (EACs) for Earned Value purposes. Explained here are the most common methods. Each method has pros and cons and should be carefully considered prior to use. Combinations and variations are possible, but they should be completed systematically and documented as such.

1) Use actual costs-to-date (AC) plus a new cost estimate of all remaining work scope (ETC) to determine EAC. At any given point in a project, until completion, there is work remaining. This method takes a Detailed, Unit-Cost, or Activity-Based approach to establishing the cost of this remaining work to assert the EAC. This method is most normally used when there have been significant variances, or there have been significant changes to risks/assumptions, schedules, or other cost drivers.

$$EAC = AC + ETC$$

2) Use actual costs-to-date (AC) plus the remaining budget at completion (BAC - EV) to determine the EAC. This method is most normally used when variances are atypical.

$$EAC = AC + (BAC - EV)$$

3) Use actual costs-to-date (AC) plus the remaining budget at completion (BAC - EV), modified by the CPI, to determine the EAC. This method is most normally used when past performance (or productivity) is considered typical and there are no anticipated changes in that productivity.

$$EAC = AC + (BAC - EV)/CPI$$

Information on DOE's Earned Value Management Information Center can be found at: <a href="http://www.evms.doe.gov/">http://www.evms.doe.gov/</a>

More general information on Earned Value can be found at: http://www.acq.osd.mil/pm/

# **Section 4.6 - Final Project Cost Report**

At the completion of a project, the final costs (or last EAC) should be collected and submitted to DOE for analysis and use as historical cost information. Analysis of historical cost data should include some form of *data normalization*, which brings all data to some common understanding, whether local (to be used with location adjustment factors), current (to be used with standard historical cost indices), or another adjusting method. A statement of a project's final cost should be made as a part of the project completion report and lessons learned report.

Historical cost information is discussed more in Section 5.4 - Historical Cost Information.

# **CHAPTER 5 - COST ESTIMATING EXPECTATIONS**

**SECTION 5.1 - SUMMARY OF EXPECTATIONS** 

**SECTION 5.2 - TRENDING** 

**SECTION 5.3 - BENCHMARKING** 

SECTION 5.4 - HISTORICAL COST INFORMATION

**SECTION 5.5 - LESSONS LEARNED** 

CHAPTER 5 - COST ESTIMATING EXPECTATIONS will explain what is expected from the use of DOE cost estimates.

Some terms and concepts use in this chapter and defined in Chapter 7 are:

- Review criteria
- Trending
- Benchmarking
- Historical cost information
- Lessons learned

## **Section 5.1 - Summary of Expectations**

Several different adjectives may be used to describe *what is expected* of DOE cost estimates. Cost estimates, regardless of purpose, classification, or technique employed, are expected to maintain quality or status that would infer that it is appropriate for its intended use, has been completed appropriately, and has survived some *internal* checks and balances. It should also be clear, concise, reliable, fair, reasonable, and accurate (within some probability or confidence levels). There could be more, depending on the program, project, contract type, specific budget requirements, or other situations.

Also, common elements of cost estimates are expected to be constant. For instance, <u>all</u> cost estimates generally should:

- 1. Be organized by a Work Breakdown Structure (WBS)
- 2. Be based on a specific Scope of Work (SOW)
- 3. Include all direct and indirect costs, appropriately
- 4. Include escalation based on the schedule, appropriately
- 5. Include contingency, to assure project success or to reflect some confidence level
- 6. Use appropriate cost estimating techniques
- 7. Include appropriate cost estimate documentation
- 8. Consider previous cost estimate versions, appropriately
- 9. Include life-cycle costs, appropriately
- 10. Be produced by qualified cost estimators

These aspects, or Review Criteria, are described in more detail in Section 3.3 - Reviews, and are included in Appendix 6.5 for easy reference.

Other expectations include various sorts of organization. Examples include resource, organization (or OBS), Code of Accounts (COA), or other similar codes, appropriate for the type of work represented by the cost estimate. These codes facilitate project management and earned value systems, and can provide extremely useful information as projects are completed. Industry standard codes are exemplified by the CSI's Uniformat II and Masterformat, for construction-type projects. Other code structures include the Environmental Cost Element Structure (ECES, formerly the HTRW), an ASTM standard for environmental projects. Some of these industry standard codes are listed in the Appendices.

Other formats, such as Project Data Sheets (PDSs) for budget formulation, should be produced also, as necessary.

More information on the Uniformat II can be found at:

http://www.uniformat.com/background.html

More information on the Masterformat can be found at:

http://www.csinet.org/technic/mflite.htm

More information on the ECES can be found at:

http://www.em.doe.gov/cost/eces.html

More information on DOE Budget Formulation, with examples of Project data Sheets can be found at:

http://www.mbe.doe.gov/budget/guidance/fy2005/field/Handbook.pdf

More information on OMB's Exhibit 300 forms can be found in OMB A-11, Part 7 at: http://www.whitehouse.gov/omb/circulars/a11/2002/part7.pdf

# **Section 5.2 - Trending**

Trending is a term used during the execution of a project to explain quantitatively how a project is progressing. Performance measurement, or Earned Value (EV) data, is another way to explain project progress. Trending is especially useful when large quantities of materials are the objective of a project, (e.g., mass excavations - measured in cubic yards or cubic meters; mass concrete construction placement - cubic yards or cubic meters; structural steel fabrication/installation (tons), etc. For instance, periodic trending uses actual costs (AC) to date per the total number of units produced to provide a report of current costs per unit. Variations, up and down, from the previous periodic trending information can help a project with decisions regarding resources (people, equipment, etc.) and near-term planning adjustments.

# **Section 5.3 - Benchmarking**

*Benchmarking* is a way to establish commercial norms and expectations, heuristics, or rules-of-thumb. Benchmarks are categorized and may be useful when other means of establishing reasonable estimates are unavailable.

An example of a benchmark is "Design should be 6% of construction." In this case, if you can calculate construction costs (even approximate, using a parametric technique), then design should be 6% of that. There are many benchmarks:

- Large equipment installation costs should be x% of the cost of the equipment
- Process piping costs should be x\% of the process equipment costs
- Commercial types of work (brick and mortar, construction) should cost approximately that of current, local, commercial work at DOE facilities (using industry standard publications, etc.)

Benchmarking information is contained in Appendix 6.11. These benchmarks will be updated periodically to reflect current information.

#### Section 5.4 - Historical Cost Information

At the completion of a project, the final costs (or last EAC) should be collected and submitted to DOE for analysis and use as historical cost information. Analysis of historical cost data should include some form of *data normalization*, which brings all data to some common understanding, whether local (to be used with location adjustment factors), current (to be used with standard historical cost indices), or another adjusting method.

Historical cost information can be depicted as Lump Sum (representing some specific scope of work), unit cost (costs per unit), or productivity (hours per unit, or units per hour). With each element or activity, materials, labor, equipment, and other costs should be addressed or at least recognized for future use. Normally there are *parameters* with which to establish unit rates; however, where there are many parameters, some may be acknowledged as *secondary parameters*. The use of parameters in estimating future projects is the essence of the Parametric cost estimating technique.

A statement of a project's final cost should be made as a part of the project completion report and lessons learned report. Historical costs should be provided to DOE for analysis, normalization, and use in future project cost estimates.

## **Section 5.5 - Lessons Learned**

Lessons learned are, just like they sound, what we've learned from experience. In some cases, this implies historical cost information. Lessons may be learned from almost anything. Lessons Learned programs are essential to structuring the information and its sharing or communication. It can establish systematic processes and procedures. It can make information retrieval relatively easy and useable. Lessons learned from a project should be planned for and collected, rather than done last-minute or by trying to look back to recollect.

Lessons learned that can help cost estimators with future cost estimates may be generic in nature or specific to a site, location, contract type, etc. They may apply to a particular scope of work or a cost estimating technique. There are many ways to communicate lessons learned. The point is to document what you've learned from the experience and share it with others, as appropriate. Some lessons learned (from other sources and

experience) are contained in Appendix 6.13.

Information on DOE's Lessons Learned program can be obtained at: <a href="http://www.tis.eh.doe.gov/ll/index.html">http://www.tis.eh.doe.gov/ll/index.html</a>

Information on Best Practices established by DOE's Energy Facility Contractors Group (EFCOG) can be obtained at:

http://efcog.org/Best%20Practices/Best%20Practices.htm

Information on DOE's Environmental Management Cost Estimating and Validation Lessons Learned Workshops can be obtained at: <a href="http://www.em.doe.gov/aceteam/training.html">http://www.em.doe.gov/aceteam/training.html</a>

# **CHAPTER 6 - APPENDICES**

- SECTION 6.1 SUMMARY OF FEDERAL REQUIREMENTS
- SECTION 6.2 SUMMARY OF DOE REQUIREMENTS
- SECTION 6.3 AACE RECOMMENDED PRACTICE NO. 17R-97
- SECTION 6.4 AACE RECOMMENDED PRACTICE NO. 18R-97
- SECTION 6.5 REVIEW CRITERIA
- SECTION 6.6 PROJECT DATA SHEETS
- SECTION 6.7 TEC/OPC/TPC (PB)
- SECTION 6.8 EXAMPLE OF THE CALCULATION AND USE OF CONTINGENCY
- SECTION 6.9 EXAMPLE OF THE CALCULATION AND USE OF ESCALATION
- SECTION 6.10 EXAMPLE OF LIFE CYCLE COST ANALYSIS
- SECTION 6.11 BENCHMARKS
- SECTION 6.12 LESSONS LEARNED

## **Section 6.1 - Summary of Federal Requirements**

This section includes a summary of federal requirements stemming from the Office of Management and Budget, the Code of Federal Regulation, and other federal laws that drive the DOE requirements relative to cost estimating.

OMB Circular No. A-11: Preparing, Submitting, and Executing the Budget, 2002, and in particular, "Part 7: Planning, Budgeting, Acquisition, and Management of Capital Assets"

Provides the framework to guide federal agencies through the process of formulating a Cost-Benefit Analysis and ultimately the budget submission for federal agency projects and programs. Major capital investments proposed for funding must:

- Support agency missions
- Support work redesign to cut costs and improve efficiency and use of off-the-shelf technology
- Be supported by a Cost-Benefit Analysis based on both qualitative and quantitative measures
- Integrate work processes and information flows with technology to achieve the strategic goals
- Incorporate clear measures to determine not only a project's success, but also its compliance with a security plan
- Be acquired through a strategy that allocates the risk between the Government and contractor and provides for the effective use of contracting
- Ensure that the Capital Plan is operational and supports the Information Resource Management (IRM) Strategic Plan

# OMB Circular No. A-94: Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs, October 1992

Provides an analytical framework for capital planning and investment control for information technology investments. The circular provides the information necessary to complete a thorough review of an IT investment's financial performance. Requirements include:

- Provide evidence of a projected return on investment in the form of reduced cost; increased quality, speed or flexibility; and improved customer and employee satisfaction
- Prepare a cost-benefit analysis for each information system throughout the life cycle that describes the:
  - Level of investment
  - Performance measures
  - A consistent methodology with regard to discount rates for cost-benefit analyses of federal programs

# Code of Federal Regulation, Title 10, Section 436, (10CFR436) Part A: Methodology and Procedures for Life Cycle Cost Analysis

Establishes a methodology and procedures for estimating and comparing the life cycle costs of federal buildings, for determining the life cycle cost effectiveness of energy conservation measures and water conservation measures, and for rank ordering life cycle cost-effective measures in order to design a new federal building or to retrofit an existing federal building. It also establishes the method by which efficiency shall be considered when entering into or renewing leases of federal building space.

## Chief Financial Officer (CFO) Act of 1990, P.L. 101-576

Section 902, a. lists the CFO's regular duties. Among other things, these include:

Develop and maintain an integrated agency accounting and financial management system, including financial reporting and internal controls, which:

- Complies with applicable accounting principles, standards, and requirements, and internal control standards
- Complies with such policies and requirements as may be prescribed by the Director of the Office of Management and Budget
- Complies with any other requirements applicable to such systems
- Provides for:
  - Complete, reliable, consistent, and timely information which is prepared on a uniform basis and which is responsive to the financial information needs of agency management
  - The development and reporting of cost information
  - The integration of accounting and budgeting information
  - The systematic measurement of performance

Direct, manage, and provide policy guidance and oversight of agency financial management personnel, activities, and operations, including:

- The preparation and annual revision of an agency plan to (i) implement the 5-year financial management plan prepared by the Director of the Office of Management and Budget under section 3512(a)(3) of this title and (ii) comply with the requirements established under sections 3515 and subsections (e) and (f) of section 3521 of this title
- The development of agency financial management budgets
- The recruitment, selection, and training of personnel to carry out agency financial management functions
- The approval and management of agency financial management systems design or enhancement projects
- The implementation of agency asset management systems, including systems for cash management, credit management, debt collection, and property and inventory management and control

The CFO Act also set requirements for submission of annual financial statements and annual external audits.

#### Government Performance and Results Act (GPRA) of 1993, P.L. 103-62

Establishes the foundation for budget decision making to achieve strategic goals in order to meet agency mission objectives. The purpose of GPRA is to provide for the establishment of strategic planning and performance measurement in the federal government.

GPRA changes the way the federal government does business; changes the accountability of federal managers; shifts organizational focus to service quality and customer satisfaction; and improves how information is made available to the public. GPRA states that an organization's mission should drive its activities. Furthermore, GPRA states that the final measure of federal program effectiveness and efficiency is results, and it requires organizations to measure their results through stated goals. It requires the development of annual performance plans and agency strategic plans. It requires a return on investment that equals or exceeds those of alternatives.

# Federal Financial Management Integrity Act (FFMIA) of 1996 as Codified in 31 U.S.C. 3512, P.L. 97-255)

Requires accountability of financial and program managers for financial results of actions taken, control over the federal government's financial resources, and protection of federal assets.

## Paperwork Reduction Act of 1995

Requires that agencies perform their information resource management activities in an efficient, effective, and economical manner.

# Federal Acquisition Streamlining Act (FASA) of 1994

Requires agencies to establish cost, schedule, and measurable performance goals for all major acquisition programs and achieve, on average, 90% of those goals. OMB policy for performance-based management is also provided in this section.

# Clinger-Cohn Act, or Information Technology Management Reform Act (ITMRA), of 1995/1996

Requires agencies to use a disciplined capital planning and investment control process to acquire, use, maintain, and dispose of information technology (IT). Directs the OMB to establish clear and concise direction regarding investments in major information systems and to enforce that direction through the budget process. The spirit and intent of ITMRA directs agencies to ensure that IT investments are improving mission performance by:

- Establishing goals to improve the efficiency and effectiveness of agency operations and, as appropriate, the delivery of services to the public through the effective use of information technology
- Ensuring that performance measurements are to measure how well the information technology supports programs of the executive agency
- Quantitatively benchmarking processes in terms of cost, speed, productivity, and quality of outputs and outcomes where comparable processes and organizations in the public or private sectors exist
- Analyzing the missions of each executive agency and, based on the analysis, revising the executive agency's processes as appropriate before making significant investments in information technology
- Ensure that the information security policies, procedures, and practices of the executive agency are adequate

### Asbestos Hazard Emergency Response Act (AHERA) of 1986

Requires school districts to analyze asbestos problems.

# Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980/1986

Federal statute (also known as Superfund) that provides the statutory authority for cleanup of hazardous substances that could endanger public health, welfare, or the environment. CERCLA addresses the uncontrolled releases of hazardous substances to the environment and the cleanup of former or otherwise inactive waste sites.

## National Emission Standards for Hazardous Air Pollutants (NESHAP)

Clean Air Act limits for release of hazardous pollutants for which no ambient air quality standard is applicable.

#### National Environmental Policy Act (NEPA) of 1969

Establishes the requirement for conducting environmental reviews of federal actions that have the potential for adverse impact on the human environment. NEPA requires that DOE perform an environmental review, with public participation, of proposed major

federal actions that may have an impact on the human environment. This review usually results in an Environmental Assessment or Environmental Impact Statement.

# Superfund

The fund set up by CERCLA for cleanup of abandoned hazardous waste sites; a colloquial term used to describe CERCLA.

### Superfund Amendments and Reauthorization Act (SARA) of 1987

Act amending and reauthorizing CERCLA for responding to hazardous waste sites and increasing the size of the fund.

# Federal Procurement Regulation (FAR)

The FAR has many references to cost estimates and cost estimating. Some topics covered by the FAR that should be considered, especially in relation to the procurement or acquisition process, include:

- Acquisition
- Acquisition Planning
- Alternate
- Architect-Engineering Services
- Best Value
- Bundling
- Change Order
- Claim
- Commercial Item
- Component
- Computer Software
- Construction
- Contract
- Cost or Pricing Data
- Cost Realism
- Cost Sharing
- Design-to-Cost
- Final Indirect Cost Rate
- FOB-Destination
- FOB-Origin
- Forward Pricing Rate Agreement
- Freight

- General and Administrative (G&A) Expense
- Indirect Cost
- Indirect Cost Rate
- Information Technology
- Inherently Government Function
- Inspection
- Insurance
- Major System
- Make-or-Buy Program
- Market Research
- Option
- Overtime
- Overtime Premium
- Performance-Based Contracting
- Pricing
- Residual Value
- Task Order
- Value Engineering
- Value Engineering Change Proposal
- Warranty
- Waste Reduction

Cost estimating and related topics can be found in the following sections of the FAR:

Part 7 - Acquisition Planning

Part 10 - Market Research

Part 14 - Sealed Bidding

Part 15 - Contracting by Negotiations

15.4 - Contract Pricing - Contains information on proposal analysis, cost and price analysis, technical analysis, and cost realism.

15.402 - Pricing policy - Says "Contracting officers must (a) Purchase supplies and services from responsible sources at fair and reasonable prices . . ." 15.407-5 - Estimating systems.

# Part 16 - Contract Types

16.4 - Incentive Contracts - Discusses establishing reasonable and attainable targets that are clearly communicated to the contractor; and including appropriate incentive arrangements in contracts.

16.402-2, f) - Says "Because performance incentives present complex problems in contract administration, the contracting officer should negotiate them in full coordination with Government engineering and pricing specialists."

Part 34 - Major System Acquisitions

Part 35 - Research and Development Contracting

Part 36 - Construction and Architect-Engineering Contracts

Part 37 - Service Contracting

Part 42 - Contract Administration and Audit Services

Part 43 - Contract Modifications

Part 48 - Value Engineering

# **Section 6.2 - Summary of DOE Requirements**

There are at least 38 DOE Orders which reference *cost estimating*. Among them, the primary DOE Orders are:

- DOE O 413.3 Program and Project Management for the Acquisition of Capital Assets - Promotes the systematic acquisition of projects and emphasizes the necessity for managing successful projects. DOE O 413.3 defines particulars of the CD process: establishing protocol, authorities, and consistency between the DOE programs.
- DOE O 430.1b Real Property Asset Management, Draft (RPAM) Establishes a
  corporate, holistic, and performance-based approach to real property life cycle
  asset management that links real property asset planning, programming,
  budgeting, and evaluation to program mission projections and performance
  outcomes. The implementation of RPAM maintains requirements for cost

estimates and LCCA. RPAM also includes DOE's requirements of the Facilities Information Management (FIMS) and the Condition Assessment and Information System (CAIS). These systems require cost estimate information concerning Replacement Plant Values (RPVs) and facility maintenance costs.

- DOE O 130.1 Budget Formulation Establishes the processes for developing, reviewing, and exchanging budget data. DOE O 130.1 requires that budget formulation be performance based, in support of the DOE strategic plans, measurable, verifiable, and based on cost estimates deemed reasonable by the cognizant program and field offices.
- DOE O 520.1 Office of Chief Financial Officer Promotes the achievement of the objectives of the CFO Act: sound financial management policies and practices, effective internal controls, accurate and timely financial information, and well-qualified financial managers by setting forth the functions, organizational roles, and specific financial management responsibilities of the CFO, the field CFOs, and other appropriate DOE officials.
- DOE O 534.1 Accounting Designates the requirements and responsibilities for the accounting and financial management of the DOE. Requirements include, but are not limited to: establishing a single, integrated financial management system that serves program management, budgetary, and accounting needs to ensure that the DOE and integrated contract records contain sufficient details in accounting for all DOE funds, assets, liabilities, and costs.
- DOE O 542.1 Competition in Contracting Ensures compliance with the
  Competition in Contracting Act of 1994, the Federal Acquisition Streamlining
  Act of 1994, the Clinger-Cohn Act of 1996, the Federal Procurement Regulation
  (FAR), and other applicable laws and regulations. It also ensures that the
  acquisition of all goods and services, with certain exceptions as listed in FAR part
  6.302, be made by full and open competition, and encourages the acquisition of
  commercial items.

# Recommended Practice No. 17R-97

Cost Estimate Classification System



August 12, 1997

# Section 6.3 - Cost Estimate Classifications (AACE Recommended Practice No. 17R-97)

#### **PURPOSE**

As a recommended practice of AACE International, the Cost Estimate Classification System provides guidelines for applying the general principles of estimate classification to asset project cost estimates. Asset project cost estimates typically involve estimates for capital investment, and exclude operating and life-cycle evaluations. The Cost Estimate Classification System maps the phases and stages of asset cost estimating together with a generic maturity and quality matrix that can be applied across a wide variety of industries.

This guideline and its addenda have been developed in a way that:

- provides common understanding of the concepts involved with classifying project cost estimates, regardless of the type of enterprise or industry the estimates relate to;
- fully defines and correlates the major characteristics used in classifying cost estimates so that enterprises may unambiguously determine how their practices compare to the guidelines;
- uses degree of project definition as the primary characteristic to categorize estimate classes; and
- Reflects generally-accepted practices in the cost engineering profession.

An intent of the guidelines is to improve communication among all of the stakeholders involved with preparing, evaluating, and using project cost estimates. The various parties that use project

cost estimates often misinterpret the quality and value of the information available to prepare cost estimates, the various methods employed during the estimating process, the accuracy level expected from estimates, and the level of risk associated with estimates.

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This classification guideline is intended to help those involved with project estimates to avoid misinterpretation of the various classes of cost estimates and to avoid their misapplication and misrepresentation. Improving communications about estimate classifications reduces business costs and project cycle times by avoiding inappropriate business and financial decisions, actions, delays, or disputes caused by misunderstandings of cost estimates and what they are expected to represent.

This document is intended to provide a guideline, not a standard. It is understood that each enterprise may have its own project and estimating processes and terminology, and may classify estimates in particular ways. This guideline provides a generic and generally-acceptable classification system that can be used as a basis to compare against. If an enterprise or organization has not yet formally documented its own estimate classification scheme, then this guideline may provide an acceptable starting point.

#### INTRODUCTION

An AACE International guideline for cost estimate classification for the process industries was developed in the late 1960s or early 1970s, and a simplified version was adopted as an ANSI

Standard Z94.0 in 1972. Those guidelines and standards enjoy reasonably broad acceptance within the engineering and construction communities and within the process industries. This

recommended practice guide and its addenda improves upon these standards by:

- 1. providing a classification method applicable across all industries; and
- 2. unambiguously identifying, cross-referencing, benchmarking, and empirically evaluating the multiple characteristics related to the class of cost estimate.

This guideline is intended to provide a generic methodology for the classification of project cost estimates in any industry, and will be supplemented with addenda that will provide extensions and additional detail for specific industries.

#### CLASSIFICATION METHODOLOGY

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There are numerous characteristics that can be used to categorize cost estimate types. The most significant of these are degree of project definition, end usage of the estimate, estimating methodology, and the effort and time needed to prepare the estimate. The "primary" characteristic used in this guideline to define the classification category is the degree of project definition. The other characteristics are "secondary."

Categorizing cost estimates by degree of project definition is in keeping with the AACE International philosophy of Total Cost Management, which is a quality-driven process applied during the entire project life cycle. The discrete levels of project definition used for classifying estimates correspond to the typical phases and gates of evaluation, authorization, and execution often used by project stakeholders during a project life cycle.

Five cost estimate classes have been established. While the level of project definition is a continuous spectrum, it was determined from benchmarking industry practices that three to five discrete categories are commonly used. Five categories are established in this guideline as it is easier to simplify by combining categories than it is to arbitrarily split a standard.

The estimate class designations are labeled Class 1, 2, 3, 4, and 5. A Class 5 estimate is based upon the lowest level of project definition, and a Class 1 estimate is closest to full project definition and maturity. This arbitrary "countdown" approach considers that estimating is a process whereby successive estimates are prepared until a final estimate closes the process.

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	Primary Characteristic	Secondary Characteristic			
ESTIMATE CLASS  LEVEL OF PROJECT DEFINITION Expressed as % of complete definition		END USAGE Typical purpose of estimate	METHODOLOGY Typical estimating method	EXPECTED ACCURACY RANGE Typical +/- range relative to best index of 1 [a]	PREPARATION EFFORT Typical degree of effort relative to least cost index of 1 [b]
Class 5	0% to 2%	Screening or Feasibility	Stochastic or Judgment	4 to 20	1
Class 4	1% to 15%	Concept Study or Feasibility	Primarily Stochastic	3 to 12	2 to 4
Class 3	10% to 40%	Budget, Authorization, or Control	Mixed, but Primarily Stochastic	2 to 6	3 to 10
Class 2	30% to 70%	Control or Bid/ Tender	Primarily Deterministic	1 to 3	5 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Deterministic	1	10 to 100

**Notes:** 

[a] If the range index value of "1" represents +10/-5%, then an index value of 10 represents +100/-50%.
[b] If the cost index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%.

Figure 1 – Generic Cost Estimate Classification Matrix

# **DEFINITIONS OF COST ESTIMATE CHARACTERISTICS**

The following are brief discussions of the various estimate characteristics used in the estimate classification matrix. For the secondary characteristics, the overall trend of how each characteristic varies with the degree of project definition (the primary characteristic) is provided.

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# **Level of Project Definition (Primary Characteristic)**

This characteristic is based upon percent complete of project definition (roughly corresponding to percent complete of engineering). The level of project definition defines maturity or the extent and types of input information available to the estimating process. Such inputs include project scope definition, requirements documents, specifications, project plans, drawings, calculations, learnings from past projects, reconnaissance data, and other information that must be developed to define the project. Each industry will have a typical set of deliverables that are used to support the class of estimates used in that industry. The set of deliverables becomes more definitive and complete as the level of project definition (e.g., project engineering) progresses.

# **End Usage (Secondary Characteristic)**

The various classes (or phases) of cost estimates prepared for a project typically have different end uses or purposes. As the level of project definition increases, the end usage of an estimate

typically progresses from strategic evaluation and feasibility studies to funding authorization and budgets to project control purposes.

# **Estimating Methodology (Secondary Characteristic)**

Estimating methodologies fall into two broad categories: stochastic and deterministic. In stochastic methods, the independent variable(s) used in the cost estimating algorithms are generally something other than a direct measure of the units of the item being estimated. The cost estimating relationships used in stochastic methods often are somewhat subject to conjecture. With deterministic methods, the independent variable(s) are more or less a definitive measure of the item being estimated. A deterministic methodology is not subject to significant conjecture. As the level of project definition increases, the estimating methodology tends to progress from stochastic to deterministic methods.

# **Expected Accuracy Range (Secondary Characteristic)**

Estimate accuracy range is in indication of the degree to which the final cost outcome for a given project will vary from the estimated cost. Accuracy is traditionally expressed as a +/- percentage range around the point estimate after application of contingency, with

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a stated level of confidence that the actual cost outcome would fall within this range (+/-measures are a useful simplification, given that actual cost outcomes have different frequency distributions for different types of projects). As the level of project definition increases, the expected accuracy of the estimate tends to improve, as indicated by a tighter +/- range.

Note that in figure 1, the values in the accuracy range column do not represent + or percentages, but instead represent an index value relative to a best range index value of 1. If, for a particular industry, a Class 1 estimate has an accuracy range of +10/-5 percent, then a Class 5 estimate in that same industry may have an accuracy range of +100/-50 percent.

# **Effort to Prepare Estimate (Secondary Characteristic)**

The level of effort needed to prepare a given estimate is an indication of the cost, time, and resources required. The cost measure of that effort is typically expressed as a percentage of the total project costs for a given project size. As the level of project definition increases, the amount of effort to prepare an estimate increases, as does its cost relative to the total project cost. The effort to develop the project deliverables is not included in the effort metrics; they only cover the cost to prepare the cost estimate itself.

Characteristics

#### RELATIONSHIPS AND VARIATIONS OF CHARACTERISTICS

There are a myriad of complex relationships that may be exhibited among the estimate characteristics within the estimate classifications. The overall trend of how the secondary characteristics vary with the level of project definition was provided above. This section explores those trends in more detail. Typically, there are commonalties in the secondary characteristics between one estimate and the next, but in any given situation there may be wide variations in usage, methodology, accuracy, and effort.

The level of project definition is the "driver" of the other characteristics. Typically, all of the secondary characteristics have the level of project definition as a primary determinant. While the other characteristics are important to categorization, they lack complete consensus. For example, one estimator's "bid" might be another's "budget." Characteristics such as "accuracy" and "methodology" can vary markedly from one industry to another, and even from estimator to estimator within a given industry.

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# **Level of Project Definition**

Each project (or industry grouping) will have a typical set of deliverables that are used to support a given class of estimate. The availability of these deliverables is directly related to the level of project definition achieved. The variations in the deliverables required for an estimate are too broad to cover in detail here; however, it is important to understand what drives the variations. Each industry group tends to focus on a defining project element that "drives" the estimate maturity level. For instance, chemical industry projects are "process-equipment centric" (i.e., the level of project definition and subsequent estimate maturity level is significantly determined by how well the equipment is defined). Architectural projects tend to be "structure-centric," software projects tend to be "function-centric," and so on. Understanding these drivers puts the differences that may appear in the more detailed industry addenda into perspective.

# **End Usage**

While there are common end usages of an estimate among different stakeholders, usage is often relative to the stakeholder's identity. For instance, an owner company may use a given of estimate to support project funding, while a contractor may use the same class of estimate to support a contract bid or tender. It is not at all uncommon to find stakeholders categorizing their estimates by usage-related headings such as "budget," "study," or "bid." Depending on the stakeholder's perspective and needs, it is important to understand that these may actually be all the same class of estimate (based on the primary characteristic of level of project definition achieved).

#### **Estimating Methodology**

As stated previously, estimating methodologies fall into two broad categories: stochastic and deterministic. These broad categories encompass scores of individual methodologies. Stochastic

methods often involve simple or complex modeling based on inferred or statistical relationships between costs and programmatic and/or technical parameters. Deterministic methods tend to be straightforward counts or measures of units of items multiplied by known unit costs or factors. It is important to realize that any combination of methods may be found in any given class of estimate. For example, if a stochastic method is known to be suitably accurate, it may be used in place of a deterministic method even when there is sufficient input information based on the level of project definition to support a deterministic method. This may be due to the lower level of effort required to

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prepare an estimate using stochastic methods.

# **Expected Accuracy Range**

The accuracy range of an estimate is dependent upon a number of characteristics of the estimate input information and the estimating process. The extent and the maturity of the input information as measured by percentage completion (and related to level of project definition) is a highly-important determinant of accuracy. However, there are factors besides the available input information that also greatly affect estimate accuracy measures. Primary among these are the state of technology in the project and the quality of reference cost estimating data.

State of technology - technology varies considerably between industries, and thus affects estimate accuracy. The state of technology used here refers primarily to the programmatic or technical uniqueness and complexity of the project. Procedurally, having "full extent and maturity" in the estimate basis deliverables is deceptive if the deliverables are based upon assumptions regarding uncertain technology. For a "first-of-a-kind" project there is a lower level of confidence that the execution of the project will be successful (all else being equal). There is generally a higher confidence for projects that repeat past practices. Projects for which research and development are still under way at the time that the estimate is prepared are particularly subject to low accuracy expectations. The state of technology may have an order of magnitude (10 to 1) effect on the accuracy range.

Quality of reference cost estimating data - accuracy is also dependent on the quality of reference cost data and history. It is possible to have a project with "common practice" in technology, but with little cost history available concerning projects using that technology. In addition, the estimating process typically employs a number of factors to adjust for market conditions, project location, environmental considerations, and other estimate-specific conditions that are often uncertain and difficult to assess. The accuracy of the estimate will be better when verified empirical data and statistics are employed as a basis for the estimating process, rather than assumptions.

In summary, estimate accuracy will generally be correlated with estimate classification (and therefore the level of project definition), all else being equal. However, specific accuracy ranges will typically vary by industry. Also, the accuracy of any given estimate is not fixed or determined by its classification category. Significant

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variations in accuracy from estimate to estimate are possible if any of the determinants of accuracy, such as technology, quality of reference cost data, quality of the estimating process, and skill and knowledge of the estimator vary. Accuracy is also not necessarily determined by the methodology used or the effort expended. Estimate accuracy must be evaluated on an estimate-by-estimate basis, usually in conjunction with some form of risk analysis process.

### **Effort to Prepare Estimate**

The effort to prepare an estimate is usually determined by the extent of the input information available. The effort will normally increase as the number and complexity of the project definition

deliverables that are produced and assessed increase. However, with an efficient estimating methodology on repetitive projects, this relationship may be less defined. For instance, there are combination design/estimating tools in the process industries that can often automate much of the design and estimating process. These tools can often generate Class 3 deliverables and estimates from the most basic input parameters for repetitive-type projects. There may be similar tools in other industry groupings.

It also should be noted that the estimate preparation costs as a percentage of total project costs will vary inversely with project size in a nonlinear fashion. For a given class of estimate, the preparation cost percentage will decrease as the total project costs increase. Also, at each class of estimate, the preparation costs in different industries will vary markedly. Metrics of estimate preparation costs normally exclude the effort to prepare the defining project deliverables.

#### ESTIMATE CLASSIFICATION MATRIX

The five estimate classes are presented in figure 1 in relationship to the identified characteristics. Only the level of project definition determines the estimate class. The other four characteristics are secondary characteristics that are generally correlated with the level of project definition, as discussed above.

This generic matrix and guideline provide a high-level estimate classification system that is nonindustry specific. Refer to subsequent addenda for further guidelines that will provide more detailed information for application in specific industries. These will provide additional information, such as input deliverable checklists, to allow meaningful

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categorization in that industry.

# **REFERENCES**

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# Recommended Practice No. 18R-97

Cost Estimate Classification System – As Applied in Engineering, Procurement, and Construction for the Process Industries



June 15, 1998

# Section 6.4 - Cost Estimate Types (AACE Recommended Practice No. 18R-97)

#### **PURPOSE**

As a recommended practice of AACE International, the Cost Estimate Classification System provides guidelines for applying the general principles of estimate classification to project cost estimates (i.e., cost estimates that are used to evaluate, approve, and/or fund projects). The Cost Estimate Classification System maps the phases and stages of project cost estimating together with a generic maturity and quality matrix, which can be applied across a wide variety of industries.

This addendum to the generic recommended practice provides guidelines for applying the principles of estimate classification specifically to project estimates for engineering, procurement, and construction (EPC) work for the process industries. This addendum supplements the generic recommended practice (17R-97) by providing:

- a section that further defines classification concepts as they apply to the process industries;
- charts that compare existing estimate classification practices in the process industry; and
- a chart that maps the extent and maturity of estimate input information (project definition deliverables) against the class of estimate.

As with the generic standard, an intent of this addendum is to improve communications among all of the stakeholders involved with preparing, evaluating, and using project cost estimates specifically for the process industries.

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Procurement, and Construction for the Process Industries



June 15, 1998

It is understood that each enterprise may have its own project and estimating processes and terminology, and may classify estimates in particular ways. This guideline provides a generic and generally acceptable classification system for process industries that can be used as a basis to compare against. It is hoped that this addendum will allow each user to better assess, define, and communicate their own processes and standards in the light of generally-accepted cost engineering practice.

## **INTRODUCTION**

For the purposes of this addendum, the term process industries is assumed to include firms involved with the manufacturing and production of chemicals, petrochemicals, and hydrocarbon

processing. The common thread among these industries (for the purpose of estimate classification) is their reliance on process flow diagrams (PFDs) and piping and instrument diagrams (P&IDs) as primary scope defining documents. These documents are key deliverables in determining the level of project definition, and thus the extent and maturity of estimate input

information.

Estimates for process facilities center on mechanical and chemical process equipment, and they have significant amounts of piping, instrumentation, and process controls involved. As such, this addendum may apply to portions of other industries, such as pharmaceutical, utility, metallurgical, converting, and similar industries. Specific addendums addressing these industries may be developed over time.

This addendum specifically does not address cost estimate classification in nonprocess industries such as commercial building construction, environmental

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Procurement, and Construction for the Process Industries



June 15, 1998

remediation, transportation infrastructure, "dry" processes such as assembly and manufacturing, "soft asset" production such as software development, and similar industries. It also does not specifically address estimates for the exploration, production, or transportation of mining or hydrocarbon materials, although it may apply to some of the intermediate processing steps in these systems.

The cost estimates covered by this addendum are for engineering, procurement, and construction (EPC) work only. It does not cover estimates for the products manufactured by the process facilities, or for research and development work in support of the process industries. This guideline does not cover the significant building construction that may be a part of process plants. Building construction will be covered in a separate addendum.

This guideline reflects generally-accepted cost engineering practices. This addendum was based upon the practices of a wide range of companies in the process industries from around the world, as well as published references and standards. Company and public standards were solicited and reviewed by the AACE International Cost Estimating Committee. The practices were found to have significant commonalities that are conveyed in this addendum.

# COST ESTIMATE CLASSIFICATION MATRIX FOR THE PROCESS INDUSTRIES

The five estimate classes are presented in figure 1 in relationship to the identified characteristics. Only the level of project definition determines the estimate class. The other four characteristics are secondary characteristics that are generally correlated with the level of project definition, as discussed in the generic standard. The characteristics are typical for the process industries but may vary from application to application.

This matrix and guideline provide an estimate classification system that is specific to

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the process industries. Refer to the generic standard for a general matrix that is nonindustry specific, or to other addendums for guidelines that will provide more detailed information for application in other specific industries. These will typically provide additional information, such as input deliverable checklists to allow meaningful categorization in those particular industries.

	Primary Characteristic	Secondary Characteristic			
ESTIMATE CLASS	LEVEL OF PROJECT DEFINITION Expressed as % of complete definition	END USAGE Typical purpose of estimate	METHODOLOGY Typical estimating method	EXPECTED ACCURACY RANGE Typical variation in low and high ranges [a]	PREPARATION EFFORT Typical degree of effort relative to least cost index of 1 [b]
Class 5	0% to 2%	Concept Screening	t Screening Capacity Factored, Parametric Models, Judgment, or Analogy		1
Class 4	1% to 15%	1% to 15% Study or Feasibility		L: -15% to -30% H: +20% to +50%	2 to 4
Class 3	10% to 40%	Budget, Authorization, or Control	Semi-Detailed Unit Costs with Assembly Level Line Items	L: -10% to -20% H: +10% to +30%	3 to 10
Class 2	30% to 70%	Control or Bid/ Tender	Detailed Unit Cost with Forced Detailed Take-Off	L: -5% to -15% H: +5% to +20%	4 to 20
Class 1	50% to 100%	Check Estimate or Bid/Tender	Detailed Unit Cost with Detailed Take- Off	L: -3% to -10% H: +3% to +15%	5 to 100

Notes: [a] The state of process technology and availability of applicable reference cost data affect the range markedly.

The +/- value represents typical percentage variation of actual costs from the cost estimate after application of contingency (typically at a 50% level of confidence) for given scope.

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[b] If the range index value of "1" represents 0.005% of project costs, then an index value of 100 represents 0.5%. Estimate preparation effort is highly dependent upon the size of the project and the quality of estimating data and

Figure 1. – Cost Estimate Classification Matrix for Process Industries

#### CHARACTERISTICS OF THE ESTIMATE CLASSES

The following charts (figures 2a through 2e) provide detailed descriptions of the five estimate classifications as applied in the process industries. They are presented in the order of least-defined estimates to the most-defined estimates. These descriptions include brief discussions of each of the estimate characteristics that define an estimate class.

For each chart, the following information is provided.

- ANSI Standard Reference (1972) Name: this is a reference to the equivalent estimate class in the existing ANSI standards.

  Alternate Estimate Names, Terms, Expressions, Synonyms: this section provides
- other commonly used names that an estimate of this class might be known by. These alternate names are not endorsed by this Recommended Practice. The user is cautioned that an alternative name may not always be correlated with the class of estimate as identified in the chart.
- Description: a short description of the class of estimate, including a brief listing of the expected estimate inputs based on the level of project definition.
- **Level of Project Definition Required:** expressed as a percent of full definition. For the process industries, this correlates with the percent of engineering and design complete.
- End Usage: a short discussion of the possible end usage of this class of estimate. Estimating Methods Used: a listing of the possible estimating methods that may be employed to develop an estimate of this class.
- Expected Accuracy Range: typical variation in low and high ranges after the application of contingency (determined at a 50% level of confidence). Typically, this results in a 90% confidence that the actual cost will fall within the bounds of the low and high ranges.
- **Effort to Prepare:** this section provides a typical level of effort (in hours) to produce a complete estimate for a US\$20,000,000 plant. Estimate preparation effort is highly

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dependent on project size, project complexity, estimator skills and knowledge, and on the availability of appropriate estimating cost data and tools.

# Class 5 Estimate

#### ANSI Standard Reference Z94.2-1989 Name:

Order of magnitude estimate (typically -30% to +50%).

Alternate Estimate Names, Terms, Expressions, Synonyms: Ratio, ballpark, blue sky, seat-of-pants, ROM, idea study, prospect estimate, concession license estimate, guesstimate, rule-of-thumb.

#### Description:

Class 5 estimates are generally prepared based on very limited information, and subsequently have wide accuracy ranges. As such, some companies and organizations have elected to determine that due to the inherent inaccuracies, such estimates cannot be classified in a conventional and systemic manner. Class 5 estimates, due to the requirements of end use, may be prepared within a very limited amount of time and with little effort expended, sometimes requiring less than an hour to prepare. Often, little more than proposed plant type, location, and capacity are known at the time of estimate preparation.

#### Level of Project Definition Required:

0% to 2% of full project definition.

#### End Usage:

Class 5 estimates are prepared for any number of strategic business planning purposes, such as but not limited to market studies, assessment of initial viability, evaluation of alternate schemes, project screening, project location studies, evaluation of resource needs and budgeting, long-range capital planning, etc.

#### **Estimating Methods Used:**

Class 5 estimates virtually always use stochastic estimating methods such as cost/capacity curves and factors, scale of operations factors, Lang factors, Hand factors, Chilton factors, Peters-Timmerhaus factors, Guthrie factors, and other parametric and modeling techniques.

#### **Expected Accuracy Range:**

Typical accuracy ranges for Class 5 estimates are - 20% to -50% on the low side, and +30% to +100% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.

#### Effort to Prepare (for US\$20MM project):

As little as 1 hour or less to perhaps more than 200 hours, depending on the project and the estimating methodology used.

Figure 2a. – Class 5 Estimate

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#### Class 4 Estimate

ANSI Standard Reference **Z94.2-1989** Name: Budget estimate (typically -15% to + 30%).

Alternate Estimate Names, Terms, Expressions, Synonyms: Screening, top-down, feasibility, authorization, factored, predesign, pre-study.

#### **Description:**

Class 4 estimates are generally prepared based on limited information and subsequently have fairly wide accuracy ranges. They are typically used for project screening, determination of feasibility, concept evaluation, and preliminary budget approval. Typically, engineering is from 1% to 5% complete, and would comprise at a minimum the following: plant capacity, block schematics, indicated layout, process flow diagrams (PFDs) for main process systems, and preliminary engineered process and utility equipment lists.

#### Level of Project Definition Required:

1% to 15% of full project definition.

#### **End Usage:**

Class 4 estimates are prepared for a number of purposes, such as but not limited to, detailed strategic planning, business development, project screening at more developed stages, alternative scheme analysis, confirmation of economic and/or technical feasibility, and preliminary budget approval or approval to proceed to next stage.

#### **Estimating Methods Used:**

Class 4 estimates virtually always use stochastic estimating methods such as equipment factors, Lang factors, Hand factors, Chilton factors, Peters-Timmerhaus factors, Guthrie factors, the Miller method, gross unit costs/ratios, and other parametric and modeling techniques.

#### **Expected Accuracy Range:**

Typical accuracy ranges for Class 4 estimates are -15% to -30% on the low side, and +20% to +50% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.

#### Effort to Prepare (for US\$20MM project):

Typically, as little as 20 hours or less to perhaps more than 300 hours, depending on the project and the estimating methodology used.

Figure 2b. – Class 4 Estimate

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#### Class 3 Estimate

# ANSI Standard Reference **Z94.2-1989** Name: Budget estimate (typically -15% to + 30%).

# Alternate Estimate Names, Terms, Expressions, Synonyms: Budget, scope, sanction, semi-detailed, authorization, preliminary control, concept study, development, basic engineering phase estimate, target estimate.

#### **Description:**

Class 3 estimates are generally prepared to form the basis for budget authorization, appropriation, and/or funding. As such, they typically form the initial control estimate against which all actual costs and resources will be monitored. Typically, engineering is from 10% to 40% complete, and would comprise at a minimum the following: process flow diagrams, utility flow diagrams, preliminary piping and instrument diagrams, plot plan, developed layout drawings, and essentially complete engineered process and utility equipment lists.

#### Level of Project Definition Required:

10% to 40% of full project definition.

#### **End Usage:**

Class 3 estimates are typically prepared to support full project funding requests, and become the first of the project phase "control estimates" against which all actual costs and resources will be monitored for variations to the budget. They are used as the project budget until replaced by more detailed estimates. In many owner organizations, a Class 3 estimate may be the last estimate required and could well form the only basis for cost/schedule control.

#### **Estimating Methods Used:**

Class 3 estimates usually involve more deterministic estimating methods than stochastic methods. They usually involve a high degree of unit cost line items, although these may be at an assembly level of detail rather than individual components. Factoring and other stochastic methods may be used to estimate less-significant areas of the project.

#### **Expected Accuracy Range:**

Typical accuracy ranges for Class 3 estimates are -10% to -20% on the low side, and +10% to +30% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.

#### Effort to Prepare (for US\$20MM project):

Typically, as little as 150 hours or less to perhaps more than 1,500 hours, depending on the project and the estimating methodology used.

Figure 2c. – Class 3 Estimate

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#### Class 2 Estimate

ANSI Standard Reference Z94.2-1989 Name: Definitive estimate (typically -5% to + 15%).

Alternate Estimate Names, Terms, Expressions, Synonyms: Detailed control, forced detail, execution phase, master control, engineering, bid, tender, change order estimate.

#### **Description:**

Class 2 estimates are generally prepared to form a detailed control baseline against which all project work is monitored in terms of cost and progress control. For contractors, this class of estimate is often used as the "bid" estimate to establish contract value. Typically, engineering is from 30% to 70% complete, and would comprise at a minimum the following: process flow diagrams, utility flow diagrams, piping and instrument diagrams, heat and material balances, final plot plan, final layout drawings, complete engineered process and utility equipment lists, single line diagrams for electrical, electrical equipment and motor schedules, vendor quotations, detailed project execution plans, resourcing and work force plans, etc.

#### Level of Project Definition Required:

30% to 70% of full project definition.

#### End Usage:

Class 2 estimates are typically prepared as the detailed control baseline against which all actual costs and resources will now be monitored for variations to the budget, and form a part of the change/variation control program.

#### **Estimating Methods Used:**

Class 2 estimates always involve a high degree of deterministic estimating methods. Class 2 estimates are prepared in great detail, and often involve tens of thousands of unit cost line items. For those areas of the project still undefined, an assumed level of detail takeoff (forced detail) may be developed to use as line items in the estimate instead of relying on factoring methods.

#### **Expected Accuracy Range:**

Typical accuracy ranges for Class 2 estimates are -5% to -15% on the low side, and +5% to +20% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.

#### Effort to Prepare (for US\$20MM project):

Typically, as little as 300 hours or less to perhaps more than 3,000 hours, depending on the project and the estimating methodology used. Bid estimates typically require more effort than estimates used for funding or control purposes.

Figure 2d. – Class 2 Estimate

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#### Class 1 Estimate

ANSI Standard Reference Z94.2 Name:

Definitive estimate (typically -5% to + 15%).

Alternate Estimate Names, Terms, Expressions, Synonyms: Full detail, release, fall-out, tender, firm price, bottoms-up, final, detailed control, forced detail, execution phase, master control, fair price, definitive, change order estimate.

#### **Description:**

Class I estimates are generally prepared for discrete parts or sections of the total project rather than generating this level of detail for the entire project. The parts of the project estimated at this level of detail will typically be used by subcontractors for bids, or by owners for check estimates. The updated estimate is often referred to as the current control estimate and becomes the new baseline for cost/schedule control of the project. Class 1 estimates may be prepared for parts of the project to comprise a fair price estimate or bid check estimate to compare against a contractor's bid estimate, or to evaluate/dispute claims. Typically, engineering is from 50% to 100% complete, and would comprise virtually all engineering and design documentation of the project, and complete project execution and commissioning plans.

#### Level of Project Definition Required:

50% to 100% of full project definition.

#### **End Usage:**

Class 1 estimates are typically prepared to form a current control estimate to be used as the final control baseline against which all actual costs and resources will now be monitored for variations to the budget, and form a part of the change/variation control program. They may be used to evaluate bid checking, to support vendor/contractor negotiations, or for claim evaluations and dispute resolution.

#### **Estimating Methods Used:**

Class 1 estimates involve the highest degree of deterministic estimating methods, and require a great amount of effort. Class 1 estimates are prepared in great detail, and thus are usually performed on only the most important or critical areas of the project. All items in the estimate are usually unit cost line items based on actual design quantities.

#### **Expected Accuracy Range:**

Typical accuracy ranges for Class 1 estimates are -3% to -10% on the low side, and +3% to +15% on the high side, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. Ranges could exceed those shown in unusual circumstances.

#### Effort to Prepare (for US\$20MM project):

Class 1 estimates require the most effort to create, and as such are generally developed for only selected areas of the project, or for bidding purposes. A complete Class 1 estimate may involve as little as 600 hours or less, to perhaps more than 6,000 hours, depending on the project and the estimating methodology used. Bid estimates typically require more effort than estimates used for funding or control purposes.

Figure 2e. – Class 1 Estimate

#### COMPARISON OF CLASSIFICATION PRACTICES

Figures 3a through 3c provide a comparison of the estimate classification practices of various firms, organizations, and published sources against one another and against the guideline classifications. These tables permits users to benchmark their own classification practices.

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	AACE Classification Standard	ANSI Standard Z94.0	AACE Pre-1972	Association of Cost Engineers (UK) ACostE	Norwegian Project Management Association (NFP)	American Society of Professional Estimators (ASPE)	
		Order of Magnitude Estimate -30/+50			Concession Estimate		
	Class 5		Order of Magnitude Estimate	Order of Magnitude Estimate Class IV -30/+30	Exploration Estimate	Level 1	
INCREASING PROJECT DEFINITION					Feasibility Estimate		
		Budget Estimate	Study Estimate	Study Estimate Class III -20/+20	Authorization Estimate		
	Class 4					Level 2	
		-15/+30			Master Control		
	Class 3		Preliminary Estimate	Budget Estimate Class II -10/+10	Estimate	Level 3	
	Class 2	Definitive Estimate	Definitive Estimate	Definitive Estimate	Current Control	Level 4	
Ļ	Class 1	-5/+15	Detailed Estimate	Class I -5/+5	Estimate	Level 5	
						Level 6	

Figure 3a. - Comparison of Classification Practices

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Class 5	Class S	Class V	Class A Prospect Estimate	Class V	
3.000	Strategic Estimate	Estimate	Class B Evaluation Estimate	Class V	
Class 4	Class 1	Class IV	Class C Feasibility Estimate	Class IV	
	Conceptual Estimate	Screening Estimate	Class D Development		
	Class 2	Class III Primary Control	Estimate	Class III	
Class 3	Semi-Detailed Estimate	Estimate	Class E Preliminary Estimate	0.000	
		Class II	Class F	Class II	
Class 2	Class 3	Estimate	Master Control Estimate	0.000	
Class 1	Detailed Estimate	Class I Current Control Estimate	Current Control Estimate	Class I	
	Class 5  Class 4  Class 3  Class 2	Class 3  Class 2  Class 2  Class 2  Class 3  Class 3	AACE Classification Standard  Products Company (Confidential)  Class 5  Class S Strategic Estimate  Class 1  Conceptual Estimate  Class 1  Class 2  Semi-Detailed Estimate  Class 2  Class 2  Class 3  Class 3  Detailed Estimate  Major Oil Company (Confidential)  Class V  Order of Magnitude Estimate  Class IV  Screening Estimate  Class III  Primary Control Estimate  Class II  Master Control Estimate  Class I  Current Control	Class 5   Class 5   Class 8   Strategic Estimate   Class 1   Conceptual Estimate   Class 1   Class 2   Semi-Detailed Estimate   Class 2   Class 2   Class 2   Class 3   Detailed Estimate   Class 1   Class 1   Class 2   Class 2   Class 3   Class 6   Class 1   Class	

Figure 3b. - Comparison of Classification Practices

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	AACE Classification Standard	J.R. Heizelman, 1988 AACE Transactions [1]	K.T. Yeo, The Cost Engineer, 1989 [2]	Stevens & Davis, 1988 AACE Transactions [3]	P. Behrenbruck, Journal of Petroleum Technology, 1993 [4]	
NOIL	Class 5	Class V	Class V Order of Magnitude	Class III*	Order of Magnitude	
PROJECT DEFINITION	Class 4	Class IV	Class IV Factor Estimate		Study Estimate	
	Class 3	Class III	Class III Office Estimate	Class II		
INCREASING	Class 2 Class II		Class II Definitive Estimate		Budget Estimate	
	Class 1	Class I	Class I Final Estimate	Class I	Control Estimate	

<sup>[1]</sup> John R. Heizelman, ARCO Oil & Gas Co., 1988 AACE Transactions, Paper V3.7

Figure 3c. - Comparison of Classification Practices

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<sup>[2]</sup> K.T. Yeo, The Cost Engineer, Vol. 27, No. 6, 1989

<sup>[3]</sup> Stevens & Davis, BP International Ltd., 1988 AACE Transactions, Paper B4.1 (\* Class III is inferred)

<sup>[4]</sup> Peter Behrenbruck, BHP Petroleum Pty., Ltd., article in Petroleum Technology, August 1993

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#### ESTIMATE INPUT CHECKLIST AND MATURITY MATRIX

Figure 4 maps the extent and maturity of estimate input information (deliverables) against the five estimate classification levels. This is a checklist of basic deliverables found in common practice in the process industries. The maturity level is an approximation of the degree of completion of the deliverable. The degree of completion is indicated by the following letters.

- None (blank): development of the deliverable has not begun.
- Started (S): work on the deliverable has begun. Development is typically limited to sketches, rough outlines, or similar levels of early completion.
- Preliminary (P): work on the deliverable is advanced. Interim, cross-functional reviews have usually been conducted. Development may be near completion except for final reviews and approvals.
- Complete (C): the deliverable has been reviewed and approved as appropriate.

	ESTIMAT	ESTIMATE CLASSIFICATION				
General Project Data:	CLASS 5	CLASS 4	CLASS 3	CLASS 2	CLASS 1	
Project Scope Description	General	Preliminary	Defined	Defined	Defined	
Plant Production/Facility Capacity	Assumed	Preliminary	Defined	Defined	Defined	
Plant Location	General	Approximate	Specific	Specific	Specific	
Soils & Hydrology	None	Preliminary	Defined	Defined	Defined	
Integrated Project Plan	None	Preliminary	Defined	Defined	Defined	
Project Master Schedule	None	Preliminary	Defined	Defined	Defined	
Escalation Strategy	None	Preliminary	Defined	Defined	Defined	
Work Breakdown Structure	None	Preliminary	Defined	Defined	Defined	
Project Code of Accounts	None	Preliminary	Defined	Defined	Defined	
Contracting Strategy	Assumed	Assumed	Preliminary	Defined	Defined	
Engineering Deliverables:						
Block Flow Diagrams	S/P	P/C	С	C	С	
Plot Plans		S	P/C	C	С	
Process Flow Diagrams (PFDs)		S/P	P/C	C	С	
Utility Flow Diagrams (UFDs)		S/P	P/C	C	C	
Piping & Instrument Diagrams (P&IDs)		S	P/C	C	C	

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Heat & Material Balances	S	P/C	С	С
Process Equipment List	S/P	P/C	C	С
Utility Equipment List	S/P	P/C	C	C
Electrical One-Line Drawings	S/P	P/C	C	C
Specifications & Datasheets	S	P/C	C	С
General Equipment Arrangement Drawings	S	P/C	C	С
Spare Parts Listings		S/P	P	С
Mechanical Discipline Drawings		S	P	P/C
Electrical Discipline Drawings		S	P	P/C
Instrumentation/Control System Discipline Drawings		S	P	P/C
Civil/Structural/Site Discipline Drawings		S	P	P/C

Figure 4. – Estimate Input Checklist and Maturity Matrix

#### REFERENCES

ANSI Standard Z94.2-1989. **Industrial Engineering Terminology: Cost Engineering**. AACE International Recommended Practice No.17R-97, **Cost Estimate Classification System**.

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# Section 6.5 - Review Criteria

When reviewing DOE cost estimates, these criteria should be considered a minimum. All criteria should be addressed to be complete, and if all criteria are reasonably addressed, then the estimates represented should be considered reasonable.

### 1. Work Breakdown Structure (WBS)

A WBS should be consistent between the technical definition, cost estimate, and schedule. The use of a common WBS should be considered for consistency between projects within a Program WBS. Use of a standardized Code of Accounts is also recommended.

# 2. Scope of Work

A Scope of Work should be commensurate with the planning phase size and complexity of the project and should be activity based to the most practical extent.

## 3. Direct and Indirect Costs

All direct costs should be included appropriately, *and* rates applied as percentages—including contract indirect and overhead rates or site indirect rates—should be documented and referenced in the basis of estimate. Indirect rates should be defined for consistent application and appropriate for a given project.

#### 4. Escalation

Escalation should be included appropriately. The rates applied should be based upon those provided by DOE, or they should have some other documented basis. Escalation is the provision in cost estimates for increases in the cost of equipment, material, labor, etc., due to continuing price changes over time. Escalation is used to estimate the future cost of a project or to bring historical costs to the present.

## 5. Contingency

Contingency should be included appropriately based on apparent project risks or project Risk Analysis, to the most possible extent. In any event, contingency should have a documented basis. Contingency may be calculated using a Deterministic or Probabilistic approach, but the method employed should be appropriate and documented.

Contingency is an amount included in an estimate to cover costs that may result from incomplete design, unforeseen and unpredictable conditions, or uncertainties. Contingency should also be commensurate with risk - a factor, element, constraint, or course of action in a project that introduces the uncertainty of outcomes and the possibilities of technical deficiencies, inadequate performances, schedule delays, or cost overruns that could impact a Departmental mission. In the evaluation of project risk, the potential impact and the probability of occurrence must be considered.

Contingency is most significant and appropriate for long-term projects and most Order of Magnitude and Preliminary estimate classes with significant size and complexity. Contingency is less significant and appropriate for nearer term projects with less significant size and complexity.

# 6. Techniques

Cost estimating techniques employed should be appropriately based on estimate class and purpose, available technical information, time constraints, and compliance with planning and project size and complexity. The chosen techniques should facilitate systematic cost estimate duplication or verification.

#### 7. Cost Estimate Documentation

Cost estimate documentation should be easily discernable, traceable, and consistent. As a matter of great relative importance, cost estimate documentation should be very thorough (i.e., provided to the most possible extent). In most cases, documentation should be specific for a given project (or sub-project), and should be centrally maintained to assure technical/cost/schedule consistency, management focus, and ease of reference.

# 8. Cost Estimate Updates

Cost estimate updates should be considered and included, as appropriate, to reflect new information, given a project planning phase and/or execution. Whether considering information contained in a previous estimate supporting a CD, a potential change to a project/contract/budget, or a Value Engineering study, previous versions of cost estimates should be appropriately considered.

## 9. Life-Cycle Costs

Life-cycle costs should be appropriately included in estimates. Life cycle cost estimates are most pertinent during the decision-making phases of a project's life, or when LCC Analyses (comparison of life cycle cost estimates or VE Studies) are performed, but should also be considered throughout a project's life.

Life-cycle costs should include: start-up costs, operating costs, manufacturing costs, machining costs, research and development costs, engineering costs, design costs, equipment costs, construction costs, inspection costs, and decommissioning costs, as well as direct costs, indirect costs, overhead costs, fees, contingency, and escalation costs.

# 10. Qualified Cost Estimators

Normally, cost estimators/cost engineers are an important part of an Integrated Project Team. Cost estimates should be performed and documented by those qualified to do so. Professional cost estimators and cost engineers are trained in the use of cost estimating tools, techniques, and all aspects of estimating, project control, and project management.

# **Section 6.6 - Project Data Sheets**

[Excerpt from FY2005 Field Budget Handbook]

# 4. Project Data Sheet (PDS) (EWD).

#### a. Overview.

- (1) Project data sheets (PDS) justify real property capital improvement projects exceeding \$5 million regardless of the funding source. They are the primary documents used to defend funding for capital projects throughout the budget formulation process. Also, data from the PDS are used to develop the OMB Circular A-11 Project Status Report to meet performance reporting requirements of the Federal Acquisition Streamlining Act (FASA) and A-11, Section 300, Planning, Budgeting, Acquisition, and Management of Capital Assets. Submit a PDS for new project efforts and for ongoing projects that require Congressional authorization and/or appropriation in the BY. Data sheets and conceptual design reports are required prior to project validation. Only validated projects are considered for funding during the budget review process.
- (2) The PDS contains cost and schedule baseline data that support the project, including a Preliminary Baseline Estimate, Title I Baseline, and Current Baseline Estimate. These baseline estimates are established based upon the project Total Estimated Cost (TEC). A Preliminary Baseline is established when project funds are requested based on the conceptual design report and is reported throughout the life of the project. The Current Baseline represents the latest approved baseline.
- (3) Include in the capital project TEC all costs related to adding and/or retiring the following:
  - (a) Plant and equipment (including transferred equipment and materials).
  - (b) Land and improvements to land; buildings (including permanently attached equipment).
    - 1 Utilities.
    - <u>2</u> Initial movable equipment (machine tools, laboratory, office furniture).
    - <u>3</u> Equipment necessary to outfit a building or group of buildings for operation.
  - (c) Exclude initial stocks of spare parts or other materials and supplies initially chargeable to inventories. Each project is assigned to the appropriate organizational component.

## b. Project Accounting Requirements.

(1) All new projects must proportionately share site overhead/landlord costs. It is important that project cost estimates include and reflect this full proportionate share of these indirect costs. The following guidance applies to capital

- projects initiated after FY 1994: Cost Accounting Standards require that indirect costs be allocated to cost objectives in reasonable proportion to the causal and beneficial relationship of these costs to cost objectives. For purposes of allocating indirect costs to capital projects, this means that (in addition to fringe and organizational burden) an equitable share of all general, administrative, and other site-wide common support activities would be charged to all cost objectives, regardless of the type of funding. In most, if not all, instances, this would result in the application of the same overhead/indirect rate to both operating and capital projects. However, this does not preclude the use of a different rate if there are cost centers/costs which are material and do not have a causal and beneficial relationship to capital projects.
- (2) The budgets for operating expenses (OE), plant acquisition and execution (PL), and capital equipment not related to execution (CE) must be consistent with the accounting treatment prescribed in DOE Order 534.1A, Accounting, and the DOE Accounting Handbook, Chapter 10, "Plant and Capital Equipment," Section 1. Introduction, "Capitalization Criteria." DOE capitalization criteria requires that all property, plant and equipment with an initial acquisition cost of \$25,000 or more and an estimated service life of 2 years or greater be capitalized and reported in the financial statement. Use the following guidelines to determine where to budget the acquisition of land, facilities, or equipment:
  - (a) Capital Equipment Not Related to Execution capital equipment for which DOE will retain title, which cost \$25,000 or more, have an expected service life of 2 years or more, and are not required to complete a project.
  - (b) **Operating Expense** capital equipment not related to project execution required for experimental projects if the equipment will be destroyed during the experiment or will have no further value other than scrap upon completion of the experiment.
  - (c) Plant and Capital Equipment Funds:
    - 1 All land acquisition (fee or easement).
    - 2 All facilities and capital equipment necessary to complete and operate the project.
    - <u>3</u> Exception: facilities or equipment that meet the definition of R&D and that normally have an estimated life of less than 2 years may be budgeted for as operating expenses; regardless of the budget source or classification of funds, capitalize R&D facilities and equipment that meet the capitalization criteria.
- (3) Facilities and equipment leasing are permissible if it is in the best interest of the government. The following are the types of leases available:
  - (a) Lease With Option to Purchase when a lease contains an option to purchase, the lease payments may have to be capitalized.
  - (b) Lease Purchase Agreements agreements that provide for transfer of title at the end of the lease term or for the transfer of title by exercise of an option at a nominal sum unrelated to the value of the property at the time

the option is exercised are considered installment purchases; capitalize these installment purchases.

## c. General Instructions.

- (1) Submit a PDS for all capital projects requiring Congressional authorization or appropriation in the BY. A PDS should be an objective document written from the standpoint of DOE as a whole instead of one segment. Do not use personal pronouns, building and area numbers, identification of staff personnel, and unsubstantiated value judgments.
- (2) A PDS should be self-sufficient. Avoid using technical terms that have a special connotation in industry or science and require that the reader have access to other documents. Provide sufficient detail on the scope of the project to permit a careful review and evaluation of the project. However, do not provide so much detail that it precludes latitude by the manager after authorization and appropriation of the funds.
- (3) Submit a PDS for each new project and for each addition that is estimated to cost \$5 million or more. Also prepare a PDS for "Operating Expense Funded" projects with a total estimated cost of \$5 million or more. Capital projects costing less than \$5 million are funded as a General Plant Project (GPP). Submit a PDS for the multi-program, general-purpose facilities program for projects selected by the multi-program general-purpose facilities review committees.
- (4) Within a specific program, execution of a number of similar or related units may be submitted on a consolidated basis as a single project. Identify consolidated PDS subprojects as follows:
  - (a) Use separate subprojects to identify items that are not at a single location.
  - (b) Identify separate subprojects for items at the same location that require separate preliminary design work, for which initial funding will be requested in different fiscal years, when funding will be the responsibility of different decision units, or if execution start or end dates are in different fiscal years.
  - (c) For a consolidated project, identify as subprojects items that would have required designation as a subproject based on the criteria above when required due to changes in the funding, schedule, or actual performance.
- (5) If projects in the previous Congressional budget have changed data or text, add the following text below the title and use a vertical line indicator to highlight changes: "Changes from the previous Congressional budget request are denoted with a vertical line [] in the left margin".
- (6) Information for Major Systems projects must agree with the project plan baseline document. Only identify changes approved by Congress or the Energy Systems Acquisition Advisory Board (ESAAB).

# d. Specific Instructions.

- (1) Reference the following to indicate the project number, title, and location in the header for the PDS; do not abbreviate text:
  - (a) <u>Project Number</u> programs are responsible for numbers for new projects in each budget year, showing the year, organization, and sequential number of the project that also indicates appropriation for organizations with multi-appropriations; project numbers are assigned soon after receipt of data sheets at headquarters; only properly assigned numbers can be used to identify projects.
  - (b) <u>Project Title</u> project titles must be unclassified and should be sufficiently short and descriptive to permit ready reference and cannot be changed after a project number has been assigned.
  - (c) <u>Project Location</u> include location of the project in the title; for consolidated projects at more than one location, use the term "Various Locations".
  - (d) <u>Decision Unit</u> identify in the footer if the decision unit is subordinate to a program; include program name before the decision unit.
- (2) <u>Significant Changes</u> use this section only if there are major changes to a PDS (project/subproject TEC, TPC, execution end date, or scope adjustments) summarize changes between the present PDS and the PDS submitted in the previous Congressional Budget; place more extensive explanations of the changes in "Item 3".
- (3) Item 1. Construction Schedule History.
  - (a) Include one line for every year a PDS was submitted to Congress where the execution schedule (start/completion), TEC, or TPC varied from the previous year's submission. Indicate parenthetically "Preliminary Baseline Estimate," "Acquisition Performance Baseline," and "Current Baseline Estimate" next to the first fiscal year in which the respective milestone was reached. There should not be more than 1 year indicated as the date of any of the milestones:
    - <u>1 Preliminary Baseline Estimate</u> TEC based on the conceptual design report; generally, this would be the first year a PDS is submitted.
    - <u>2 Title I Baseline</u> if preliminary design is complete, show the TEC for the Title I Baseline and Current Baseline; Title I date will not change; TEC baseline (not the TPC) is used for FASA performance reporting to OMB and Congress.
    - <u>3 Current Baseline Estimate</u> show all approved changes in this line that reflects the latest TEC baseline.
  - (b) <u>Design Initiated and Completed</u>. Include planned and completed decision milestones, as well as other significant project milestones.
  - (c) <u>Total Estimated Cost</u>. For projects that contain subprojects, the TEC is the sum of the TEC for all subprojects less non-federal contributions. Identify escalation factors when estimating project costs.
  - (d) <u>Total Project Cost</u>. Insert the current federal total project cost (TPC).

- (4) <u>Item 2. Financial Schedule</u>. After the title "Financial Schedule," if applicable, indicate in parentheses "Operating Expense Funded." Obligations in the BY and outyears reflect an incremental funding policy.
  - (a) For projects that are phase funded, display funding by design and execution phases. Use the Preliminary Baseline TEC until completion of the preliminary design. Afterwards, change the Financial Schedule to reflect the Acquisition Performance Baseline TEC, or Current Baseline TEC if it is different.
  - (b) The data in this section must match the Current Baseline Estimate project schedule dates in "Item 1." The total appropriations, obligations, and costs must agree with the Current Baseline TEC in "Item 1." The financial schedule reflects all federal funding for the project from its inception and is reconciled to the Plant History Report and Financial Data System (FDS). Do not break out funds between design and execution for projects prior to FY 2002; the Congressional appropriations committee staff does not want the funds split. Show only the total funds in each fiscal year for a design and execution funded project data sheet. Use footnotes to explain significant scope, schedule, and funding changes from prior-year budget submissions:
    - 1 The "Appropriation" column for all prior years and the execution year (PY) is identical to the Office of Budget FDS Base Table amounts.
    - The "Obligations" and "Costs" columns for all prior years match Plant History Report amounts; the obligations column for the execution year (PY) is identical to the latest FDS Approved Funding Program (AFP) amount.
    - <u>3</u> The execution year obligations and costs must agree with the approved baseline for strategic and major systems projects.
    - 4 Whenever the current appropriation does not equal the original appropriation, explain the change in a footnote; include the original appropriation and the amount of the adjustment in the footnote.
- (5) Item 3. Project Description, Justification, and Scope. State clearly and concisely the essential features of the project and, if it is new, a modification, or an addition to an existing project. Describe how this project ties to the Strategic Plan or a specific program; discuss alternatives and the risks and uncertainties of meeting cost/schedule goals. Explain unusual technical terms and describe the following physical aspects if applicable. Write the description in "Item 3" so that it can be easily linked to the cost estimate in "Item 4." If the project contains subprojects, describe each subproject using the same format after a general introduction of the overall project:
  - (a) If the Current Baseline Estimate differs from the previous year's Baseline Estimate in the TEC and TPC of "Item 1," explain the factors used to determine the revised estimate; this should be consistent with summarized changes described in "Significant Changes" section.
  - (b) Describe improvements to land and, where it constitutes a major portion of the project, include data such as the approximate length, width, and types

- of roadways, approximate capacities of parking areas, and proposed drainage structures and fencing.
- (c) Describe each building or building addition, including approximate floor plan dimensions, gross area, number of stories, story heights, basement (if provided); types of construction and reason for using such if not obvious; types of heating and air-conditioning; capacities of cranes; and design, fabrication, or construction features which are unusual or specialized and have a significant impact on the cost estimate (shielding, protective construction, hot cells, special ventilation systems, environmental protection systems, and fire protection systems).
- (d) Describe other structures, such as pits, tunnels, towers, bunkers, stacks, and other enclosures not included above.
- (e) Describe types of utilities (water, sewer, and power) and, if this item constitutes a major portion of the project, include data such as the length and size of the utility lines.
- (f) Describe special facilities or equipment such as accelerator components, movable shielding, vacuum systems, processing piping, power or controls, reactor vessels, inert gas, hydrogen or purging systems, and cryogenic systems.
- (g) Describe standard equipment such as office and laboratory furniture and equipment, hoists, and machine tools.
- (h) Describe computer system or component of a computer system that have a total estimated purchase cost of \$2 million or more; provide a brief justification and explanation of the rationale for funding.
- (i) For projects not receiving the full appropriation in the BY, provide a brief description of that portion of the scope which will be accomplished with the BY appropriation.
- (j) For projects that contain subprojects:
  - <u>1</u> Provide a two-digit subproject number (01-03) preceding the subproject title and location; subproject number is used to provide Obligational Authority in the AFP and to report obligations and costs.
  - <u>2</u> Subproject numbers cannot be reused or changed during the life of the project.
  - 3 Subproject titles cannot be changed
  - <u>4</u> For each subproject description, provide the subproject TEC; cumulative appropriation for all previous years; PY, CY, and BY appropriations; cumulative outyear appropriation to complete the subproject; and execution activity start and end dates; underline and use a vertical line indicator in the left margin to identify funding profile and execution schedule changes from the previous Congressional budget request; explain changes in the text description of the subproject.
  - <u>5</u> Provide the date subproject execution activity begins and ends; if any date has changed from the date previously transmitted to Congress, use a footnote to explain change.
  - <u>6</u> Subproject amounts must sum to total project data.

- <u>a</u> Sum of TEC for all subprojects equals "Total Line Item Cost" in "Item 4" and "Line Item TEC" in "Item 6".
- $\underline{b}$  Sum of the appropriation for each fiscal year for all subprojects equals sum of the appropriation in "Item 2" for the fiscal year; sum of appropriation for previous fiscal years for all subprojects equals sum of the appropriation in "Item 2" for all fiscal years previous to the PY.
- <u>7</u> Dates in "Physical Execution Start/Complete" column is the earliest execution start date and the latest completion date for all subprojects.
- <u>8</u> Completed subprojects remain in the PDS with its funding profile; to conserve space, remove the description the year following the year it was reported completed to Congress.
- <u>9</u> Describe the R&D or production program that is ongoing or planned including the relationship of the proposed facility (both as to need and timing) to the program objectives and schedules:
- <u>a</u> State criteria that determined the size or scope of the project, such as volume of production, storage capacity, number of persons to be housed, and space requirements for research.
- <u>b</u> To maximum extent feasible within security limitations for projects involving production increases, indicate the present production rate or capacity and the change proposed; if project is an intermediate phase of a long-range program, indicate its relationship to foreseeable planned capacity; if it is a production facility, state annual capacity and basis (1-shift, 2- shift operation, 5-day week, 6-day week); if capacity involves "Top Secret" data, indices shall be used when practicable, or if not practicable, submit data separately.
- $\underline{c}$  If project replaces existing facilities, explain circumstances that necessitate replacement and disposition to be made of the replaced facilities.
- <u>d</u> Indicate that existing facilities have been reviewed to determine that the need cannot be met by modification of existing facilities; this is important for radioactive contaminated facilities where decontamination and decommissioning costs are factors.
- e State reasons for proposed timing of completion of the project and the effect on the program if the project is deferred or not authorized. f If practicable, provide data on the economics of the project including the basis for calculating savings and payout; in computing savings, comparative cost estimates include the cost of depreciation of the facility justifications can often be strengthened by reference to
- g If costs include overhead of an off-site contract laboratory operated by a university or other institution, state the reasons for including overhead and the method used to determine the overhead.
- $\underline{\mathbf{h}}$  Identify the estimated gross annual facility operating cost (excluding depreciation) upon completion, less applicable offsetting reductions;

alternatives and the consequences of disapproval.

for replacement facilities, include comparative data for the facilities being replaced:

- i. Production facilities and power-producing facilities state first full-year's operating costs, maintenance costs, and annual costs at equilibrium; show gross annual costs, revenues, other offsetting reductions, and new annual costs.
- ii. Research and development facilities (including new research machines) show separately, operating costs, maintenance costs, total cost of R&D program, and incremental program cost related to occupying the new building.
- iii. In all cases include basis for these estimates of annual cost for operations and maintenance.
- <u>10</u> Include two items of performance measurement data at appropriate level (project or subproject):
- <u>a</u> Indicate what program planning objectives the project or subproject benefits/supports.
- <u>b</u> Indicate type and amount of project or project work to be completed during the BY in quantifiable terms.
- (6) Item 4. Details of Cost Estimate.
  - (a) This section shows the estimate for each of the account classification listed below. Within each classification, give a breakdown of the costs indicating significant units and costs wherever possible.
  - (b) Present all costs in current year dollars, escalated to the midpoint o execution. Include a cost category only if there are costs; for example, I there are no costs for "Improvements to Land," do not include thi category. The "Previous Estimate" shows the previous submission t Congress. The basis for percentages is TEC. Do not show genera administrative and other indirect costs that are charged to the project instead, prorate these costs among the various cost elements. Also prorate the costs of management services by private firms during execution among the various execution costs:
    - <u>1</u> If project will be administered by an "off-site" contract with a university or other institution that will be reimbursed for administrative overhead, include a memorandum entry indicating estimated overhead; budget costs for preparing system design descriptions or comparable technical documentation to operating expense or execution consistent with the treatment of related expenditures (for example, documents prepared for conceptual design are charged to operating cost, while those performed for preliminary and final design are charged to execution; costs for preparing environmental documentation should be budgeted to operating expenses).
    - <u>2</u> Compute unit cost per square foot or cubic foot for buildings or other construction on the basis of gross areas; exclude the amount included in the estimate for contingencies; unit costs should not be more precise than warranted by the status of design.

- <u>3</u> Items should include pertinent data on quantities and unit costs; explain unusual unit costs, engineering design, and inspection or contingency rates.
- 4 Include a statement at the end of the estimate which explains the basis for the estimate (for example, "conceptual design is complete, preliminary design is 25 percent complete").
- <u>5</u> Explain why certain unit costs may be out of the normal range such as cost for special isolation requirements, costs related to speedup of execution showing hours per week on which estimate is based, and factors affecting the contingent amount.
- <u>6</u> Identify escalation rates.
- (c) The following account classifications are categorized by design or construction:

#### 1 Design Phase:

- <u>a Preliminary and Final Design costs (Design Drawings and Specifications)</u> enter total cost of preliminary and final design; additionally, in parentheses provide the cost of the design drawings and specifications; DOE Guide 430.1, Chapter 25, Guidelines for Engineering, Design, and Inspection Costs, lists design activities that can be included.
- <u>b</u> <u>Design Management Costs as a Percentage of TEC</u> identify costs for services provided by the organization managing the execution effort during preliminary and final design as a percentage of TEC; management services are further defined in DOE Order 430.1A, Life Cycle Asset Management.
- <u>c Project Management Costs as a Percent of TEC</u> report costs for a specific project during preliminary and final design for planning, organizing, directing, controlling, and project status reports; in parentheses identify the percentage of TEC.
- 2 Execution Phase (not required in a design-only PDS):
- <u>a Land and Land Rights</u> provide a breakdown identifying each site acquired, acreage or square miles involved, unit cost, and total cost or cost of each land right acquired; see DOE Order 430.1A, Life Cycle Asset Management, for on the acquisition of real property.
- <u>b</u> <u>Improvements to Land</u> indicate the types of improvements that will be made and total cost; if this sub-item constitutes a major portion of the project, express it in terms of units, unit costs, and total cost, such as miles of road at dollar per mile.
- <u>c</u> <u>Buildings</u> identify planned building construction or building additions and/or existing building modifications; include gross square feet, unit cost, and total cost; if unit cost is unusually high, provide an explanatory note.
- <u>d Special Equipment</u> identify major engineered equipment, and special systems/ facilities (accelerator components, movable shielding, vacuum systems, processing piping, power or controls,

- reactor vessels, inert gas, hydrogen or purging systems, and cryogenic systems which are also described in "Item 3;" provide an explanation if major equipment components appear to be standard in nature but are special due to unusual criteria (special engineering and/or fabrication needed to meet requirements).
- <u>e Other Structures</u> provide costs for major other structures described in "Item 3," (pits, tunnels, towers, bunkers, stacks, and other enclosures not included in "Item 3").
- <u>f Utilities</u> list types of utilities (water, sewer, and power), which are also described in "Item 3," and total cost; if this item constitutes a major portion of the project, include data such as units, unit costs, and total costs.
- g Standard Equipment list costs for major items of "off-theshelf" equipment and furnishings that require a nominal engineering effort (office and laboratory furniture and equipment, hoists, and machine tools), which are also described in "Item 3;" include engineering effort required.
- <u>h Major Computer Items</u> list and provide costs for each major computer item or component that have a total estimated purchase cost of \$2 million or more (also described in "Item 3").
- <u>i Removal Cost Less Salvage</u> include removal costs less salvage incident to the replacement of plant and equipment applicable to the project; separate projects will be established to budget and account for removal costs and salvage incident to the retirement of plant equipment that will not be replaced.
- j <u>Inspection</u>, <u>Design and Project Liaison</u>, <u>Testing</u>, <u>Checkout</u>, <u>and Acceptance</u> include design support costs coincident with execution activities (such as field drawings, management services, acceptance, testing, and checkout).
- <u>k</u> Construction Management Cost identify services provided by the organization responsible for managing the execution effort after preliminary and final design and continuing through completion of execution; management services are further defined in DOE Order 430.1A, Life Cycle Asset Management; compute the percentage of TEC.
- <u>l Project Management</u> report services provided for a specific project after the design phase and starting with the construction phase through completion, for planning, organizing, directing, controlling, and project status reports; compute the percentage of TEC.
- <u>3 Contingencies</u>: Provide a total (design and execution phase) contingency as a percentage of TEC; this contingency covers unforeseen, unpredictable situations and does not provide for increasing the scope of the project; amount of contingency depends on the status of design and complexity of the project:
- <u>a Design Phase</u> show design phase contingencies as a subtotal of total

contingencies.

- <u>b Execution Phase</u> show execution phase contingencies as a subtotal of total contingencies (not used in a design-only PDS).
- 4 Total Line Item Cost: add contingencies to subtotal
- <u>5 Less Non-Agency Contribution</u>: non-federal funds from other sources that are considered capital funds and are included in "Total line item cost;" use only if there are non-federal funds; this funding must be subtracted to show the TEC.
- <u>6 Total Line Item Cost (TEC)</u>: Net federal TEC; this is the TEC shown in "Item 1," which is the federal cost net of non-federal contribution; us e only if there are non-federal funds.
- (7) <u>Item 5. Method of Performance</u>. Indicate the type of contracting arrangement being considered, using the following as a guide:
  - (a) Design and inspection are performed under a negotiated contract execution and procurement are accomplished by fixed-price contract awarded on the basis of competitive bidding.
  - (b) Design and inspection are performed by the operating contractor; I feasible, execution and procurement will be accomplished by fixed-price contracts and subcontracts awarded on the basis of competitive bidding.
- (8) Item 6. Schedule of Project Funding.
  - (a) If the project includes subprojects, attach a separate page for each. Provide aggregated data in this section.
  - (b) Use the following definitions to develop the Total Project Cost estimates. The narrative should include a brief description of each line, its cost, basis for operating expense funding, and a schedule. Include the project start/completion dates and relevant interface dates. Include a specific cost category only if it has a cost; if there are no costs for "NEPA Documentation," omit this category:
  - (c) <u>Total Project Costs</u> all costs directly related to execution of the project 1 Design the cost for preparing the conceptual design.
    - 2 Execution not used in a design-only PDS.
    - <u>3 Project Engineering and Design (PED)</u> operating expense engineering and design costs, exclusive of the conceptual design costs.
    - <u>4 Operating Expense Funded Equipment</u> equipment, system, component, or other item funded from operating expenses for direct use of the project or is required to make the project complete and operable; include justification and examples.
    - 5 Inventories inventories needed to begin operation of the project.
  - (d) Other Project Costs escalate all estimated costs to the year of planned expenditure; show actual costs when incurred (not used in a design-only PDS):
    - <u>1 R&D Necessary to Complete Execution</u> show by fiscal year R&D costs for projects which require an R&D program as a prerequisite to specific design and execution and for which R&D funds are included in the operating expenses appropriation request.

- <u>2 Conceptual Design Costs</u> costs of conceptual design and report.
- <u>3 Decontamination and Decommissioning (D&D)</u> costs of removing hazardous material (typically radioactive or chemical material) from facilities, soils, or equipment by washing, chemical action, mechanical cleaning, or other remediation techniques; also includes costs associated with decommissioning (demolition, dismantling, and removal); see DOE Accounting Handbook, Chapter 10, "Plant and Capital Equipment".
- <u>4 NEPA Documentation Costs</u> NEPA 1969 compliance costs including EA, EIS, permitting actions, and site characterization.
- <u>5 Other ES&H Costs</u> costs associated with environmental, safety, and health activities exclusive of NEPA documentation costs included above.
- <u>6 Other Project Related Costs</u> other costs directly related to the project that occur on a one-time basis, such as start-up costs and training; include a narrative explanation and justification.
- <u>7 Non-Agency Contribution</u> non-federal funds from other sources that are considered capital funds and are included in the "Total line item cost".
- (e) <u>Item 7. Related Annual Funding Requirements</u>. This section shows the lifecycle costs for the operation and maintenance of the project. It includes annual operating costs and a narrative explanation. There are two funding columns: "Current Estimate" and "Previous Estimate." The latter shows the estimate from the previous Congressional budget request. Include the fiscal year for the funding costs. (Not used in a design-only PDS.) The following are the reporting guidelines:
  - <u>1 Total Related Annual Funding</u> show in parentheses when the annual cost will begin and end; escalate the annual cost, which will represent average per year over the useful life to the first year in which the cost will be incurred.
  - <u>2 One-Time Costs versus Annual Costs</u> explain significant variances in the annual cost estimates year to year in a footnote (for example, a planned purchase of a major item of equipment could substantially change the annual costing or significantly change the mode of operation); in addition, use a footnote to explain significant variations in the annual costing rates (for example, procuring a new nuclear reactor core on a very infrequent basis would greatly increase the annual capital equipment cost rate for a facility).
  - <u>3 Types of Costs</u> show a specific cost category (such as "Maintenance and Repair Costs") only if it has a cost; if the item has no cost, omit this cost category:
  - <u>a Annual Operating Costs</u> annual cost to operate the project, including cost of labor and materials; footnote staff years required; state whether it replaces another project; if a replacement, provide total, not incremental, costs.

- <u>b</u> <u>Maintenance and Repair Costs</u> include all maintenance and repair costs; footnote staff years required.
- <u>c Programmatic Operating Expenses Directly Related to the Project</u> include programmatic effort that relies on the direct and primary use of the project; provide a yearly estimate and brief justification in a footnote.
- <u>d Capital Equipment Related to Programmatic Effort</u> annual capital equipment requirements related to the programmatic effort included above; footnote expected installations of new capital equipment. <u>e GPP or Other Project Related to Programmatic Effort</u> – annual cost and justification of General Plant Project or other related projects included above.
- <u>f Utility Costs</u> all annual utility costs required to operate the project. <u>g Other Costs</u> other expected costs not included above; explain in footnotes.

### It goes on to provide the following definitions:

<u>Total Project Costs</u> – all costs directly related to execution of the project

- 1 Design the cost for preparing the conceptual design.
- 2 Execution not used in a design-only PDS.
- <u>3</u> Project Engineering and Design (PED) operating expense engineering and design costs, exclusive of the conceptual design costs.
- <u>4</u> Operating Expense Funded Equipment equipment, system, component, or other item funded from operating expenses for direct use of the project or is required to make the project complete and operable; include justification and examples.
- 5 Inventories inventories needed to begin operation of the project.

<u>Other Project Costs</u> – escalate all estimated costs to the year of planned expenditure; show actual costs when incurred (not used in a design-only PDS):

- <u>1</u> R&D Necessary to Complete Execution show by fiscal year R&D costs for projects which require an R&D program as a prerequisite to specific design and execution and for which R&D funds are included in the operating expenses appropriation request.
- 2 Conceptual Design Costs costs of conceptual design and report.
- <u>3</u> Decontamination and Decommissioning (D&D) costs of removing hazardous material (typically radioactive or chemical material) from facilities, soils, or equipment by washing, chemical action, mechanical cleaning, or other remediation techniques; also includes costs associated with decommissioning (demolition, dismantling, and removal); see DOE Accounting Handbook, Chapter 10, "Plant and Capital Equipment".
- <u>4</u> NEPA Documentation Costs NEPA 1969 compliance costs including EA, EIS, permitting actions, and site characterization.
- <u>5</u> Other ES&H Costs costs associated with environmental, safety, and health activities exclusive of NEPA documentation costs included above.
- <u>6</u> Other Project Related Costs other costs directly related to the project that occur on a one-time basis, such as start-up costs and training; include a narrative explanation and justification.

Non-Agency Contribution – non-federal funds from other sources that are considered capital funds and are included in the "Total line item cost". Related Annual Funding Requirements. This section shows the lifecycle costs for the operation and maintenance of the project. It includes annual operating costs and a narrative explanation. There are two funding columns: "Current Estimate" and "Previous Estimate." The latter shows the estimate from the previous Congressional budget request. Include the fiscal year for the funding costs. (Not used in a design-only PDS.) The following are the reporting guidelines:

- <u>1</u> Total Related Annual Funding show in parentheses when the annual cost will begin and end; escalate the annual cost, which will represent average per year over the useful life to the first year in which the cost will be incurred.
- <u>2</u> One-Time Costs versus Annual Costs explain significant variances in the annual cost estimates year to year in a footnote (for example, a planned purchase of a major item of equipment could substantially change the annual costing or significantly change the mode of operation); in addition, use a footnote to explain significant variations in the annual costing rates (for example, procuring a new nuclear reactor core on a very infrequent basis would greatly increase the annual capital equipment cost rate for a facility).
- <u>3</u> Types of Costs show a specific cost category (such as "Maintenance and Repair Costs") only if it has a cost; if the item has no cost, omit this cost category:
  - <u>a</u> Annual Operating Costs annual cost to operate the project, including cost of labor and materials; footnote staff years required; state whether it replaces another project; if a replacement, provide total, not incremental, costs.
  - <u>b</u> Maintenance and Repair Costs include all maintenance and repair costs; footnote staff years required.
  - <u>c</u> Programmatic Operating Expenses Directly Related to the Project include programmatic effort that relies on the direct and primary use of the project; provide a yearly estimate and brief justification in a footnote.
  - <u>d</u> Capital Equipment Related to Programmatic Effort annual capital equipment requirements related to the programmatic effort included above; footnote expected installations of new capital equipment.
  - <u>e</u> GPP or Other Project Related to Programmatic Effort annual cost and justification of General Plant Project or other related projects included above.
  - $\underline{\mathbf{f}}$  Utility Costs all annual utility costs required to operate the project.
  - g Other Costs other expected costs not included above; explain in footnotes.

# The DOE Budget Formulation Handbook also provides an example of a Project Data Sheet.

The entire DOE Field Budget Handbook can be found at: <a href="http://www.mbe.doe.gov/budget/guidance/fy2005/field/Handbook.pdf">http://www.mbe.doe.gov/budget/guidance/fy2005/field/Handbook.pdf</a>

OMB Circular A-11, Part 7, Planning, Budgeting, Acquisition, and Management of Capital Assets can be found at:

http://www.whitehouse.gov/omb/circulars/a11/2002/part7.pdf

# Section 6.7 - TEC/OPC/TPC (PB)

Table 6–1 provides a distinction between Activities and Deliverables to be included in Total Estimated Costs (TEC), Other Project Costs (OPC), Total Project Costs (TPC), Project Engineering and Design (PED) funds, and Operational Expense funds (OPEX) in various stages of a project.

Table 6-1. Project Activities and Deliverables

			CAPITAL	
ACTIVITIES/DELIVERABLES	OPEX	DED	TPC	
		PED	OPC	TEC
Prior to CD-0				
Establish Project Team	X			
Establish Program/Project Planning Budget	X			
Develop Project Scope	X			
Identify Customer Expectations	X			
Identify Key Schedule Drivers	X			
Identify Funding Constraints	X			
Identify High-Level Functions and Requirements	X			
Identify Project-Level Interfaces	X			
Identify Capital & Life Cycle Cost Drivers	X			
Develop Pre-Acquisition Design Schedule	X			
Develop Conceptual Design Schedule Range	X			
Develop Market Plan	X			
Develop Up-Front Conceptual Design Business				
Decision Estimate & Budgets	X			
Develop Pre-Acquisition Design Budget	X			
Establish Placeholder in Out-Year Budget	X			
Initiate Pre-Acquisition Planning and Design	X			
Assess Technology Maturity Phase Plan	X			
Submit CD-0 Package	X			
Develop Project-Level Functions and Requirements	X			
Identify Pre-Acquisition Risks	X			
Perform Alternative/Value Management Studies	X			
Identify Long-Lead or Special Procurement	X			
Establish Conceptual Design Budget & Schedule	X			
Develop Preliminary Design & Schedule Range	X			
Develop Preliminary/Final Design Range	X			
Develop TPC & Schedule Range	X			
Preliminary Environmental Strategy	X			
Identify Current & Next 2 FYs Funding				
Requirements	X			
Initiate PDS for Design	X			

CAPITAL **OPEX ACTIVITIES/DELIVERABLES** TPC **PED** OPC TEC Program Plan X Mission Need Independent Project Review X AS in the PASD X PDS for Design with Special Procurement Disclosure X Tech Task Request X Technology Development Issues X Prior to CD-1 Perform Project & Phase Technical and Programmatic Risk Analysis X X Develop System-Level Functions & Requirements X X Confirm Long-Lead Procurements X X Develop PEP for Preliminary Design X X Set Project Execution Strategy X X Perform Site Investigation & Alternatives X X Review Design Alternatives/Perform VM X X Identify Project Codes, Standards, & Procedures X X Update Preliminary/Final Design Cost Estimate X X Develop Preliminary Design Phase Budget & Schedule X X Update TPC & Schedule Range X X Perform Safety & Operability Review X X Identify Current & 2 FYs Funding Requirements X X X X Acquisition Strategy **Project Expectations Summary** X X SOW for Design X X CA/EIS/Record of Decision X X Systems Engineering Management Plan X X Conceptual Design Package X X Preliminary PEP X X Preliminary Hazard Analysis Report X Χ Preliminary Team Execution Plan X X **RMP** X X Preliminary Design Phase Budget and Schedule X X Verification of Mission Need X X CD-1 Package X X Updated TPC & Schedule Range X X Formal Value Management Plan X X

CAPITAL **OPEX ACTIVITIES/DELIVERABLES** TPC **PED** OPC TEC **Prior to CD-2 Define Special Procurement** X X X Develop, Validate, & Issue Phased Package, If Necessary X X X Finalize Permit Requirements X X X Finalize Team Execution Plan X X X Commit Critical Equipment X X X **Initiate Pulse Surveys** X X X Perform Process Hazards Review X X X Select Project Site X X X Update PEP X X X Update Technical and Programmatic Risk X X X **Analysis** Perform Formal Value Management X X X **Develop Baselines** X X X Develop CD-2 Package X X X Define CD-3 Deliverables & Completion Criteria X X X Update Annual/Out-Year BA X X X Prepare PDS for Construction X X X Conduct EIR X Χ X Conduct ICR or Estimate X X X Review of Contractor Project Management System X X X X X X Preliminary Design Detailed Schedules Issued for Design Source Documents X X X Assign Responsibilities Matrix X X X Performance Metrics X X X **Staffing Plans** X X X Technology Risk Analysis Report X X X Technology Development Output X X X Preliminary Safety Analysis Report X X X **EVMS** Certification X X X **NEPA** Documentation X X X Prior to CD-3 Receive Critical Vendor Data X X Finalize 3-D Computer-Aided Drafting and Design Setup X X Complete Design Model X X **Conduct Technical Innovations** X X Evaluation X X

CAPITAL **OPEX ACTIVITIES/DELIVERABLES** TPC **PED OPC** TEC Finalize Planning Drawings X X Finalize Field Support Plan X X Review Safety Action Plan X X Perform Final Design Review X X **Equipment and Material Requisitions** X X Issue for Construction Design Documents X X 100% Definitive Estimate X X Integrated Project Schedule and Sub-tier Schedules X X Updated PEP & Performance Baseline X X X Final Design & Procurement Packages X Verification of Mission Need Budget & Congressional Authorization X X Approved Safety Documentation X X X **Execution Readiness Independent Review** X **Updated Construction PDS** X X Prior to CD-4 Start Site Work X Complete Procurement of Materials and Equipment X **Start Systems Completion** X **Initiate Document Closeout Process** X Work-Off Punch Lists X X Turnover & Startup Plan Operating and Maintenance Manuals X Construction Completion X **Startup Commissioning** X X Test Plan Final Safety Analysis Report X Annual Updates X **Construction PDS** X **Following CD-4** Startup/Commissioning X Verification of Testing X Lessons Learned X X ORR & Acceptance Report X Approval for Acceptance X **As-Built Drawings** Final Safety Report X **Project Completion Report** X

# Section 6.8 - Example of the Calculation and Use of Contingency

The *Deterministic Approach* in calculating contingency is to be used for smaller, less-complex projects, especially in the early phases of a project's life. As a project evolves, it is expected to use a more *Probabilistic Approach* in establishing contingency. Contingency should always be calculated with a project's remaining costs not yet incurred, as in an Estimate-to-Complete.

## Section 6.8.1 - Steps in Calculating Contingency Using a Deterministic Approach

The following steps are an example of how to calculate contingency using a Deterministic Approach. The Deterministic Approach is most appropriate for smaller, simpler projects, and especially in the early stages of a project. These steps are generic and should be considered appropriately, but used consistently for like projects.

- <u>Step 1</u> Determine Base Cost Estimate. Have a Summary Cost Estimate (escalated), organized by the WBS.
- <u>Step 2</u> Determine Risks associated with each WBS element, from consulting with the project team.
- Step 3 Determine percentages and/or amounts of contingency, necessary to provide high and higher confidence levels, for each WBS element.
   (Percentages for contingency and confidence levels are for example only. Remember, requirements are for projects to ascertain project risks and provide resources for a successful project.)
- <u>Step 4</u> Calculate contingency.

The following example is generic, but it includes the pertinent steps in calculating contingency, using a Deterministic Approach.

<u>Step 1</u> - Determine Base Cost Estimate. Have a Summary Cost and Schedule Estimate (escalated), organized by the WBS. Table 6–2 shows a hypothetical Project Cost Estimate Summary (escalated), prior to adding contingency.

Table 6–2. Deterministic Approach Example - Step 1 Project Cost Estimate Summary (Escalated)

WBS	Scheduled Activity	Total Base Cost (000\$)	Total Escalated Costs (000\$)
A1A	Preliminary Design	100	103
A1B	Definitive Design	200	207
A1C	Design During Construction	100	109
B2A	Equipment Procurement (General Services)	200	220
B2B	Equipment Procurement (Long-Lead, GFE)	2,500	2,623
B2C	Facility Construction	6,000	6,597
C1A	Project Management	500	534
C1B	Construction Management	250	267
C1C	Project Support	250	267
Е	Contingency		
	Totals	10,100	10,927

<u>Step 2</u> - From consulting with the IPT, determine risks associated with each WBS element. Table 6–3 provides an example of a simple Risk Assessment, organized by WBS.

Table 6–3. Deterministic Approach Example - Step 2 Project Risk Assessment

WBS	Scheduled Activity	Risks
A1A	Preliminary Design	Low Risks. Not very complex or complicated. Material and equipment vendors contacted but not confirmed. Some risks in incorporating stakeholder input.
A1B	Definitive Design	Moderate Risks. Mostly commercially available technology, standard details, high degree of quality. Minor risks in general and special equipment procurement and compatibility.
A1C	Design During Construction	Moderate Risks. High degree of quality could hamper construction acceptance, may necessitate changes.

WBS	Scheduled Activity	Risks
B2A	Equipment Procurement (General Services)	Low Risks.
B2B	Equipment Procurement (Long-Lead, GFE)	Moderate Risks. Some equipment may not be able to be delivered to meet construction schedule. Tightened oversight may help.
B2C	Facility Construction	Low to Moderate Risks. Mostly commercial construction techniques. Standards higher than normal. Equipment delivery questionable.
C1A	Project Management	Low Risks.
C1B	Construction Management	Moderate Risks.
C1C	Project Support	Moderate Risks. Especially oversight for special equipment delivery.

<u>Step 3</u> - Determine percentages and/or amounts of contingency necessary to provide high confidence levels for each WBS element. (Percentages for confidence levels are for example only. Remember, requirements are for projects to ascertain project risks and provide resources for a successful project.)

Considerations for percentages used should include: completeness of design, types of construction, and contract types to be employed; estimate classifications, purposes, and methods; technologies available, reliability, co-occupancy/accessibility, environmental conditions, planning complexity (stakeholder involvement), and other unique items such as permitting and external reviews. Table 6–4 provides an example of Step 3 in using a Deterministic Approach in establishing a project's contingency. The percentage applied may be based on subjective interpretation of the risks associated with that WBS element.

Table 6–4. Deterministic Approach Example - Step 3
Project Cost Estimate Summary (Including Contingency Percentages)

WBS	Scheduled Activity	Risks	Total Escalated Costs (000\$)	Total Contingency Percentage
A1A	Preliminary Design	Low Risks. Not very complex or complicated. Material and equipment vendors contacted but not confirmed. Some risks in incorporating stakeholder input.	103	10%
A1B	Definitive Design	Moderate Risks. Mostly commercially available technology, standard details, high degree of quality. Minor risks in general and special equipment procurement and compatibility.	207	15%
A1C	Design During Construction	Moderate Risks. High degree of quality could hamper construction acceptance, may necessitate changes.	109	15%
B2A	Equipment Procurement (General Services)	Low Risks.	220	10%
B2B	Equipment Procurement (Long- Lead, GFE)	Moderate Risks. Some equipment may not be able to be delivered to meet construction schedule.  Tightened oversight may help.	2,623	20%
B2C	Facility Construction	Low to Moderate Risks.  Mostly commercial construction techniques. Standards higher than normal. Equipment delivery questionable.	6,597	20%
C1A	Project Management	Low Risks.	534	10%
C1B	Construction Management	Moderate Risks.	267	15%
C1C	Project Support	Moderate Risks. Especially oversight for special equipment delivery.	267	20%

<u>Step 4</u> - Calculate contingency (DOE-held, representing a high confidence level), as appropriate. These confidence levels should provide for a successful project, representing the Performance Baseline (PB). Table 6–5 provides an example of the calculation of contingency and depicts the Total Project Cost (TPC) or Performance Baseline (PB).

Table 6–5. Deterministic Approach Example - Step 4
Contingency Calculation

WBS	Scheduled Activity	Total Escalated Costs (000\$)	Contingency Percentage	Contingency (000\$)	Total Project Costs (000\$) (PB)
A1A	Preliminary Design	103	10%	10	103
A1B	Definitive Design	207	15%	31	207
A1C	Design During Construction	109	15%	16	109
B2A	Equipment Procurement (General Services)	220	10%	22	220
B2B	Equipment Procurement (Long-Lead, GFE)	2,623	20%	525	2,623
B2C	Facility Construction	6,597	20%	1,319	6,597
C1A	Project Management	534	10%	53	534
C1B	Construction Management	267	15%	40	267
C1C	Project Support	267	20%	53	267
Е	Contingency		16%	2,071	2,071
	Total	10,927			12,998

## Section 6.8.2 - Steps in Calculating Contingency Using a Probabilistic Approach

The follow steps are an example of how to calculate contingency using a Probabilistic Approach. These steps are generic and should be considered appropriately, but used consistently for like projects.

- Step 1 Determine Base Cost Estimate
- Step 2 Determine risks associated with each WBS element
- <u>Step 3</u> Determine Best, Expected, and Worst Case Cost Scenarios for each WBS element
- Step 4 Run Monte Carlo Simulation
- <u>Step 5</u> Determine contingency based on confidence levels shown in Monte Carlo Simulation

The following example of a Probabilistic Approach in determining contingency is generic and should be considered appropriately, but used consistently for like projects.

<u>Step 1</u> - Determine Base Cost Estimate. Table 6–6 is an example of an escalated Project Cost Estimate Summary, organized by the WBS.

Table 6–6. Probabilistic Approach Example - Step 1 Project Cost Estimate Summary (Escalated)

WBS	Scheduled Activity	Total Base Cost (000\$)	Total Escalated Costs (000\$)
A1A	Preliminary Design (Title I Design)	100	103
A1B	Definitive Design (Title II Design)	200	207
A1C	Design During Construction (Title III Design)	100	109
B2A	Equipment Procurement (General Services)	200	220
B2B	Equipment Procurement (Long-Lead, GFE)	2,500	2,623
B2C	Facility Construction	6,000	6,597
C1A	Project Management	500	534
C1B	Construction Management	250	267
C1C	Project Support	250	267
Е	Contingency		
	Totals	10,100	10,927

<u>Step 2</u> - From consulting with the IPT, determine risks associated with each WBS element. Table 6–7 is an example of a simple Risk Assessment.

Table 6–7. Probabilistic Approach Example - Step 2 Project Risk Assessment

WBS	Scheduled Activity	Risks
A1A	Preliminary Design (Title I Design)	Low Risks. Not very complex or complicated. Material and equipment vendors contacted but not confirmed. Some risks in incorporating stakeholder input.
A1B	Definitive Design (Title II Design)	Moderate Risks. Mostly commercially available technology, standard details, high degree of quality. Minor risks in general and special equipment procurement and compatibility.
A1C	Design During Construction (Title III Design)	Moderate Risks. High degree of quality could hamper construction acceptance, may necessitate changes.
B2A	Equipment Procurement (General Services)	Low Risks.
B2B	Equipment Procurement (Long-Lead, GFE)	Moderate Risks. Some equipment may not be able to be delivered to meet construction schedule. Tightened oversight may help.

WBS	Scheduled Activity	Risks
B2C	Facility Construction	Low to Moderate Risks. Mostly commercial construction techniques. Standards higher than normal. Equipment delivery questionable.
C1A	Project Management	Low Risks.
C1B	Construction Management	Moderate Risks.
C1C	Project Support	Moderate Risks. Especially oversight for special equipment delivery.

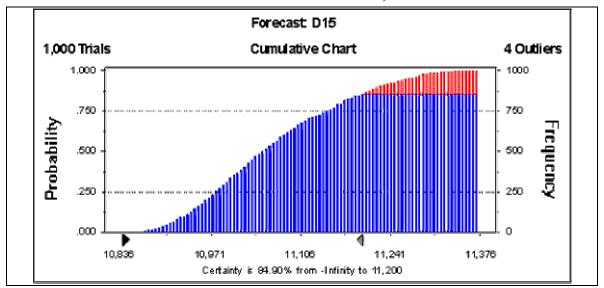
<u>Step 3</u> - Determine Best, Expected, and Worst Case Cost Scenarios. Table 6–8 is an example of a table provided by the project team depicting best, expected, and worst cases for each summary WBS element. Note: Not shown are probability distributions (Triangular, Beta, Normal, etc.) for each WBS element.

Table 6–8. Probabilistic Approach Example - Step 3 Cost Estimate Summaries (Best/Expected/Worst Cases)

WBS	Scheduled Activity	Risks	Total Escalated Costs (000\$) (Expected Case)	Best Case	Worst Case
A1A	Preliminary Design (Title I Design)	Low Risks. Not very complex or complicated. Material and equipment vendors contacted, but not confirmed. Some risks in incorporating stakeholder input.	103	100	105
A1B	Definitive Design (Title II Design)	Moderate Risks. Mostly commercially available technology, standard details, high degree of quality. Minor risks in general and special equipment procurement and compatibility.	207	185	225
A1C	Design During Construction (Title III Design)	Moderate Risks. High degree of quality could hamper construction acceptance, may necessitate changes.	109	100	125
B2A	Equipment Procurement (General Services)	Low Risks.	220	200	250
B2B	Equipment Procurement (Long-Lead, GFE)	Moderate Risks. Some equipment may not be able to be delivered to meet construction schedule.  Tightened oversight may help.	2,623	2,600	2,700
B2C	Facility Construction	Low to Moderate Risks. Mostly commercial construction techniques. Standards higher than normal. Equipment delivery questionable.	6,597	6,500	7,000
C1A	Project Management	Low Risks.	534	500	600
C1B	Construction Management	Moderate Risks.	267	250	300
C1C	Project Support	Moderate Risks. Especially oversight for special equipment delivery.	267	250	300
	Total		10,927	10,685	11,605

<u>Step 4</u> - Run Monte Carlo Simulation. Utilizing the best, expected, and worst cases, and a probability distribution curve, use Monte Carlo simulation to depict a distribution of the likely scenarios. Figure 6–1 is an example of a graphic cumulative output of a Monte Carlo simulation, indicting the ~85% confidence level.

Figure 6–1. Probabilistic Approach Example - Step 4
Results of Monte Carlo Simulation (Cumulative Distribution, with Highlighted ~ 85% Confidence Level)



<u>Step 5 -</u> From the Monte Carlo simulation, determine the amount of contingency necessary to represent the appropriate confidence level. Table 6–9 depicts Step 5 of a Probabilistic Approach, expressing contingency separate from each contributing WBS element.

Table 6–9. Probabilistic Approach Example - Step 5 Summary of Project Costs (Including Contingency)

WBS	Scheduled Activity	Total Escalated Costs (000\$)
A1A	Preliminary Design	103
A1B	Definitive Design	207
A1C	Design During Construction	109
B2A	Equipment Procurement (General Services)	220
B2B	Equipment Procurement (Long-Lead, GFE)	2,623
B2C	Facility Construction	6,597
C1A	Project Management	534
C1B	Construction Management	267
C1C	Project Support	267
Е	Contingency (DOE-Held)	273
	Total	11,200

# Section 6.9 - Example of the Calculation and Use of Escalation

#### Calculation and Use of Escalation

Escalation should be used in all estimates where a project's TPC may be impacted due to increases in unit costs or due to inflation. The following are generic steps in calculating escalation.

- <u>Step 1</u> Complete Cost and Schedule Estimates (Cost Estimate Purpose, Class, or Method does not matter, although it should be organized by the WBS).
- Step 2 Determine midpoint of primary scheduled activities. Typically, an upper-level WBS is necessary to segregate types of activities (e.g., Design, Construction). It is not necessary to calculate escalation at the lowest levels of activities, since most activities are grouped into logistical WBS elements.
- <u>Step 3</u> Select Appropriate Escalation Rates. These rates are typically based on information provided by DOE/HQ, but may be based on locally documented information.
- <u>Step 4</u> Calculate escalation for each scheduled activity by using estimate preparation date as starting point and applying escalation rates selected in Step 3 to midpoint dates determined in Step 2. A straight-line spending curve application may be assumed, although other spending curves may be used, as appropriate.

The following is an example of a five-year project requiring escalation. Tables 6–10 through 6–13 represent the steps in calculating escalation. Table 6–10 is an example of a hypothetical project cost estimate summary prior to adding escalation.

Table 6–10. Escalation Example - Step 1 -- Sample Project Cost Estimate Summary

WBS	Scheduled Activity	Total Base Cost (000\$)	Start	Duration (Months)	Complete	Midpoint
A1A	Preliminary Design (Title I Design)	100	10/1/2002	6	3/30/2003	1/1/2003
A1B	Definitive Design (Title II Design)	200	4/1/2003	6	9/30/2003	7/1/2003
A1C	Design During Construction (Title III Design)	100	10/1/2003	36	9/30/2006	7/1/2005
B2A	Equipment Procurement (General Services)	200	10/1/2004	24	9/30/2006	10/1/2005
B2B	Equipment Procurement (Long-Lead, GFE)	2,500	3/30/2003	18	9/30/2004	1/1/2004
B2C	Facility Construction	6,000	10/1/2004	37	9/30/2006	10/1/2005
C1A	Project Management	500	10/1/2002	48	9/30/2006	10/1/2004
C1B	Construction Management	250	10/1/2002	48	9/30/2006	10/1/2004
C1C	Project Support	250	10/1/2002	48	9/30/2006	10/1/2004
	Totals	10,100				

Table 6–11 is the DOE Escalation Rates (as of January 2002), available through the DOE Budget Formulation Handbook and from the Office of Engineering and Construction Management (ME-90) for projects. Rates used may be different from those provided by DOE; however there should be a sound basis for escalation rates used.

Table 6-11. DOE Escalation Rates (as of January 2002)

	Project Categories *												
FY	Constr	uction	E	М	ľ	Γ	0&	z <b>M</b>	R&D				
2002	1	N/A	1	N/A	1	N/A	1	N/A	1	N/A			
2003	1.021	2.1	1.02	2	1.008	0.8	1.018	1.8	1.023	2.3			
2004	1.046	2.5	1.047	2.7	1.017	0.9	1.045	2.6	1.051	2.8			
2005	1.076	2.9	1.075	2.7	1.022	0.5	1.073	2.7	1.08	2.7			
2006	1.106	2.8	1.103	2.6	1.032	1	1.101	2.6	1.108	2.6			
2007	1.135	2.6	1.13	2.4	1.041	0.8	1.127	2.4	1.136	2.5			

Table 6–12 is an example of a detailed spread of escalation rates through the applicable fiscal years. This example assumes a straight-line escalation for each FY, although other

applications may be appropriate (e.g., all at the beginning or end of a FY). Use of other than straight-line escalation should be well-documented.

Table 6-12. Sample Detailed Spread of Escalation Rates

Months of Escalation		0	1	2	3	4	5	6	7	8	9	10	11	12
Month of	f the Year	10	11	12	1	2	3	4	5	6	7	8	9	10
FY	Rate													
2002	2.10%	0.00%	0.17%	0.35%	0.52%	0.70%	0.87%	1.05%	1.22%	1.40%	1.57%	1.75%	1.92%	2.10%
2003	2.10%	2.10%	2.28%	2.46%	2.64%	2.81%	2.99%	3.17%	3.35%	3.53%	3.71%	3.89%	4.07%	4.24%
2004	2.50%	4.24%	4.46%	4.68%	4.90%	5.11%	5.33%	5.55%	5.76%	5.98%	6.20%	6.42%	6.63%	6.85%
2005	2.90%	6.85%	7.11%	7.37%	7.62%	7.88%	8.14%	8.40%	8.66%	8.92%	9.17%	9.43%	9.69%	9.95%
2006	2.80%	9.95%	10.21%	10.46%	10.72%	10.98%	11.23%	11.49%	11.74%	12.00%	12.26%	12.51%	12.77%	13.03%
2007	2.60%	13.03%	13.27%	13.52%	13.76%	14.01%	14.25%	14.50%	14.74%	14.99%	15.23%	15.48%	15.72%	15.97%
2008	2.60%	15.97%	16.22%	16.47%	16.72%	16.97%	17.22%	17.47%	17.72%	17.98%	18.23%	18.48%	18.73%	18.98%

Table 6–13 is an example of the Project Cost Estimate Summary with columns added to calculate the escalation, per WBS element.

Table 6–13. Sample Project Cost Estimate Summary (Including Escalation)

WBS	Scheduled Activity	Total Base Cost (000\$)	Start	Duration (Months)	Complete	Midpoint	Compounded Escalation Rate	Total Escalated Costs (000\$)
A1A	Preliminary Design (Title I Design)	100	10/1/2002	6	3/30/2003	1/1/2003	2.64%	103
A1B	Definitive Design (Title II Design)	200	4/1/2003	6	9/30/2003	7/1/2003	3.71%	207
A1C	Design during Construction (Title III Design)	100	10/1/2003	36	9/30/2006	7/1/2005	9.17%	109
B2A	Equipment Procurement (General Services)	200	10/1/2004	24	9/30/2006	10/1/2005	9.95%	220
B2B	Equipment Procurement (Long-Lead, GFE)	2,500	3/30/2003	18	9/30/2004	1/1/2004	4.90%	2,623
B2C	Facility Construction	6,000	10/1/2004	37	9/30/2006	10/1/2005	9.95%	6,597
C1A	Project Management	500	10/1/2002	48	9/30/2006	10/1/2004	6.85%	534
C1B	Construction Management	250	10/1/2002	48	9/30/2006	10/1/2004	6.85%	267
C1C	Project Support	250	10/1/2002	48	9/30/2006	10/1/2004	6.85%	267
	Totals	10,100						10,927

In calculating applicable escalation percentages, repetitive calculations are normal, so a

computerized escalation forecast program may prove beneficial. Cash flow may be assumed to be straight-line or based on a spending curve, as appropriate.



## Cost vs. Obligations - Funding Profile

A funding profile is a normal part of budget submissions. There is a difference between the timing of project costs and obligations/funding requirements. As a project evolves, it should be very clear that funds are required prior to spending them. This lead time should be carefully evaluated and established by the project team. Care should be taken to establish the most appropriate funding profile to provide for efficient use of funds and to minimize carry-over (where funds not obligated within the FY they are authorized).

It is also necessary to use common sense in applying escalation. For instance, if a construction subcontract is awarded that will cover multiple fiscal years at a competitive fixed price, it may not be necessary to apply escalation to that contract.

Once escalation has been applied, it is not normally necessary to reconsider how it is applied. However, in the context of significant changes, for example where schedules change, there may be instances where it is pertinent to consider the impact of escalation to unit costs and hourly labor rates. These types of analyses may become quite complex. Having a systematic approach to estimating escalation will help.

# Section 6.10 - Example of Life-Cycle Cost Analysis

OMB A-94 - Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs provides direction in performing Cost-Benefit Analyses, or Life-Cycle Cost Analyses (LCCA). Per OMB, LCCAs should always consider all pertinent costs and benefits. Due to the nature of projects considered in fulfilling missions of the DOE, LCCAs may include a component of benefits, which may be depicted as costs to be avoided or saved, as a result of a particular alternative. DOE has very few income or revenue streams. However, as a part of Life-Cycle Analyses, all benefits and costs should be recognized, including those that are difficult to quantify (such as benefits to the public or the general economy).

Generally the steps in performing LCCA are as follows:

- <u>Step 1</u> Determine Cost Estimate Summary funding profile for base case and for each alternative case, including all costs and benefits.
- <u>Step 2</u> Determine appropriate discount rates to be used. Note discussion on real and nominal discount rates. If escalation is included in the Cost Estimate Summary, use nominal discount rates established by OMB.
- Step 3 Calculate appropriate discount factors, using the rates determined in

Step 2.

- Step 4 Calculate present-worth (PW) of base case and each alternative case.
- <u>Step 5</u> Compare all alternatives and determine the most cost-effective alternative. The lowest PW is the preferred alternative from an economic perspective.

Following is an example that generally shows the steps to be used in performing LCCA:

<u>Step 1</u> - Determine the Cost Estimate Summary funding profile for the base case and each alternative case being considered, including all costs and benefits. It is important to ensure that similar functions and activities are considered together (e.g., consistent use of a WBS/COA) to make the scenario as comparable as possible. Table 6–14 and 6–15 are examples of these summary tables.

Table 6–14. Example LCCA – Step 1 Life Cycle Cost Estimate Summary, Base Case

	Activity	TPC	03	04	05	06	07	08	09	10	11	12	13	14	15
A1A	Preliminary Design	103	103												
A1B	Definitive Design	207	207												
A1C	Design During Construction	109		37	37	36									
B2A	Equipment Procurement (General Services)	220			110	110									
B2B	Equipment Procurement (Long-Lead, GFE)	2,623	2000	623											
B2C	Facility Construction	6,597		1500	3597	1500									
C1A	Project Management	534	75	175	175	109									
C1B	Construction Management	267	25	100	100	42									
C1C	Project Support	267	25	100	100	42									
Е	Contingency (DOE-Held)	86	10	25	25	26									
	Total Project Costs (Escalated)	11,193	2,445	2,560	4,144	1,866	1	-	ı	1	ı	ı	1	-	-
		Annual													
F	Operations (LOE)	250			269	277	284	291	299	307	315	323	331	340	349
G	Security (LOE)	100		105	108	111	114	117	120	123	126	129	132	136	139
Н	Infrastructure (LOE)	50		52	54	55	57	58	60	61	63				
I	Maintenance (LOE)	100		105	108	111	114	117	120	123	126	129	132	136	139
J	Transition (LOE)	50										65	66	68	70
K	Decontamination (LOE)	50									63	65	66	68	70
L	Decomissioning (LOE)	50									63	65	66	68	70
M	Demolition (LOE)	500										646	662	680	697
	<b>Total Operations (Escalated)</b>	21,392	2,445	2,822	4,682	2,419	568	583	598	613	755	1,420	1,457	1,495	1,534
	Total Life-Cycle Costs (Escalated)	32,585	4,890	5,382	8,826	4,285	568	583	598	613	755	1,420	1,457	1,495	1,534

Table 6–15. Example LCCA – Step 1 Life Cycle Cost Estimate Summary, Alternative Case

	Activity	TPC	03	04	05	06	07	08	09	10	11	12	13	14	15
A	Design During Construction/Renovation	50	50												
B2A	Procurement/Lease Facility	1,560	102	105	108	111	114	117	120	123	126	129	132	136	139
B2C	Facility Construction/Renovation	6,597		1500	3597	1500									
C1A	Project Management	150	25	50	50	25									
C1B	Construction Management	100	25	50	25										
C1C	Project Support	60	10	40	10										
Е	Contingency (DOE-Held)	78	5	5	5	6	6	6	6	6	6	6	7	7	7_
	<b>Total Project Costs (Escalated)</b>	11,193	217	1,750	3,795	1,641	119	122	126	129	132	136	139	143	146
		Annual													
F	Operations (LOE)	250			269	277	284	291	299	307	315	323	331	340	349
G	Security (LOE)	100		105	108	111	114	117	120	123	126	129	132	136	139
Н	Infrastructure (LOE)	50		52	54	55	57	58	60	61	63				
I	Maintenance (LOE)	100		105	108	111	114	117	120	123	126	129	132	136	139
J	Transition (LOE)	50										65	66	68	70
K	Decontamination (LOE)	50									63	65	66	68	70
L	Decomissioning (LOE)	50									63	65	66	68	70
M	Demolition (LOE)	500													
	Total Operations (Escalated)	7,693	_	262	538	554	568	583	598	613	755	775	795	816	837
	Total Life-Cycle Costs (Escalated)	18,886	217	2,012	4,334	2,195	687	705	723	742	887	910	934	958	983

<u>Step 2</u> - Determine appropriate discount rates to be used. If escalation is included in the Cost Estimate Summary, as in this example, use nominal discount rates established by OMB. The following information may also be found in OMB A-94 and is updated biannually.

<u>Nominal Discount Rates</u> - A forecast of nominal or market interest rates for 2003 based on the economic assumptions from the 2004 Budget are presented below. These nominal rates are to be used for discounting nominal flows, which are often encountered in Lease-Purchase Analysis.

Table 6–16. Nominal Interest Rates on Treasury Notes and Bonds of Specified Maturities (in Percent)

3-Year	5-Year	7-Year	10-Year	30-Year
3.1	3.6	3.9	4.2	5.1

<u>Real Discount Rates -</u> A forecast of real interest rates from which the inflation premium has been removed and based on the economic assumptions from the 2004 Budget are presented below. These real rates are to be used for discounting real (constant-dollar) flows, as is often required in cost-effective analysis.

Table 6–17. Real Interest Rates on Treasury Notes and Bonds of Specified Maturities (in Percent)

3-Year	5-Year	7-Year	10-Year	30-Year
1.6	1.9	2.2	2.5	3.2

Analyses of programs with terms different from those presented above may use a linear interpolation. For example, a four-year project can be evaluated with a rate equal to the average of the three-year and five-year rates. Programs with durations longer than thirty years may use the 30-year interest rate.

Step 3 - Calculate appropriate discount factors, using the appropriate discount rates.

The discount factor is calculated as:

$$1/(1+i)^{t}$$

where i is the discount rate and t is the year. For this example, a <u>nominal</u> discount rate is calculated for an  $\sim$ 15-year project, to be  $\sim$ 4.4%. Discount factors are calculated in Table 6–18.

Table 6–18. Example LCCA – Step 3 -- Discount Rate Application, Discount Factor Calculation

FY	Consecutive Year	Discount Rate	Discount Factor
2003	1	0.044	0.9579
2004	2	0.044	0.9175
2005	3	0.044	0.8788
2006	4	0.044	0.8418
2007	5	0.044	0.8063
2008	6	0.044	0.7723
2009	7	0.044	0.7398
2010	8	0.044	0.7086
2011	9	0.044	0.6787
2012	10	0.044	0.6501
2013	11	0.044	0.6227
2014	12	0.044	0.5965
2015	13	0.044	0.5713
2016	14	0.044	0.5473
2017	15	0.044	0.5242

<u>Step 4</u> - Calculate PW of base case and each alternative case using the discount factors calculated in Step 3. Tables 6.19 and 6.20 are examples of these tables.

Table 6–19. Example LCCA – Step 4 Cost Estimate Summary, Including Present Worth, Base Case

	Activity	TPC	03	04	05	06	07	08	09	10	11	12	13	14	15
A1A	Preliminary Design	103	103												
A1B	Definitive Design	207	207												
A1C	Design During Construction	109		37	37	36									
B2A	Equipment Procurement (General Services)	220			110	110									
B2B	Equipment Procurement (Long-Lead, GFE)	2,623	2000	623											
B2C	Facility Construction	6,597		1500	3597	1500									
C1A	Project Management	534	75	175	175	109									
C1B	Construction Management	267	25	100	100	42									
C1C	Project Support	267	25	100	100	42									
Е	Contingency (DOE-Held)	86	10	25	25	26									
	Total Project Costs (Escalated)	11,193	2,445	2,560	4,144	1,866	-	-	-	-	-	-	-	-	-
		Annual													
F	Operations (LOE)	250			269	277	284	291	299	307	315	323	331	340	349
G	Security (LOE)	100		105	108	111	114	117	120	123	126	129	132	136	139
Н	Infrastructure (LOE)	50		52	54	55	57	58	60	61	63				
I	Maintenance (LOE)	100		105	108	111	114	117	120	123	126	129	132	136	139
J	Transition (LOE)	50										65	66	68	70
K	Decontamination (LOE)	50									63	65	66	68	70
L	Decomissioning (LOE)	50									63	65	66	68	70
M	Demolition (LOE)	500										646	662	680	697
	Total Operations (Escalated)	10,378	-	262	538	554	568	583	598	613	755	1,420	1,457	1,495	1,534
	Total Life-Cycle Costs (Escalated)	21,571	2,445	2,822	4,682	2,419	568	583	598	613	755	1,420	1,457	1,495	1,534
			0.9579	0.9175	0.8788	0.8418	0.8063	0.7723	0.7398	0.7086	0.6787	0.6501	0.6227	0.5965	0.5713
	Discounted Costs (PW)	16,979	2,342	2,589	4,115	2,036	458	450	442	435	513	923	908	892	877

Table 6–20. Example LCCA – Step 4 Cost Estimate Summary, Including Present Worth, Alternative Case

	Activity	TPC	03	04	05	06	07	08	09	10	11	12	13	14	15
A	Design During Construction/Renovation	50	50												
B2A	Procurement/Lease Facility	1,560	102	105	108	111	114	117	120	123	126	129	132	136	139
B2C	Facility Construction/Renovation	6,597		1500	3597	1500									
C1A	Project Management	150	25	50	50	25									
C1B	Construction Management	100	25	50	25										
C1C	Project Support	60	10	40	10										
Е	Contingency (DOE-Held)	78	5	5	5	6	6	6	6	6	6	6	7	7	7
	Total Project Costs (Escalated)	11,193	217	1,750	3,795	1,641	119	122	126	129	132	136	139	143	146
		Annual													
F	Operations (LOE)	250			269	277	284	291	299	307	315	323	331	340	349
G	Security (LOE)	100		105	108	111	114	117	120	123	126	129	132	136	139
Н	Infrastructure (LOE)	50		52	54	55	57	58	60	61	63				
I	Maintenance (LOE)	100		105	108	111	114	117	120	123	126	129	132	136	139
J	Transition (LOE)	50										65	66	68	70
K	Decontamination (LOE)	50									63	65	66	68	70
L	Decomissioning (LOE)	50									63	65	66	68	70
M	Demolition (LOE)	500													
	<b>Total Operations (Escalated)</b>	7,693	-	262	538	554	568	583	598	613	755	775	795	816	837
	Total Life-Cycle Costs (Escalated)	18,886	217	2,012	4,334	2,195	687	705	723	742	887	910	934	958	983
			0.9579	0.9175	0.8788	0.8418	0.8063	0.7723	0.7398	0.7086	0.6787	0.6501	0.6227	0.5965	0.5713
	Discounted Costs (PW)	12,778	208	1,846	3,808	1,847	554	545	535	526	602	592	582	572	562

<u>Step 5</u> - Compare all alternatives and determine the most cost-effective alternative. The lowest PW is the preferred alternative, from an economic perspective. Table 6–21 shows an example summary of this PW comparison and clearly shows the most cost-effective alternative.

Table 6–21. Example LCCA – Step 5 -- Summary of Base Case and Alternative Discounted Costs, or PW

Activity FY	Base Case	Alt Case
03	2,342	208
04	2,589	1,846
05	4,115	3,808
06	2,036	1,847
07	458	554
08	450	545
09	442	535
10	435	526
11	513	602
12	923	592
13	908	582
14	892	572
15	877	562
PW	16,979	12,778

A standard for Life-Cycle Cost Analysis (LCCA) is currently being established by the National Institute for Science and Technology (NIST).

#### Section 6.11 - Benchmarks

The following benchmarks can be found in the text of this *DOE Cost Estimating Guide*. They are included here as a simplified reference. These may be updated periodically. Suggestions or input are appreciated.

#### **Direct Costs**

Sources of information include: historical cost information, commercially available databases, vendor "budgetary information," expert opinion, catalogues and published price lists, GSA schedules, current government contracts, previous cost estimates for similar work, and professional judgment.

#### **Indirect Costs**

A summary of Site Indirect Costs can be found at the FMSIC website: http://www.mbe.doe.gov/progliaison/fcstrpt/FY01fscr.pdf

## Field Indirect Costs/G&A

Depends on the cost account structure and current local accounting systems employed.

### **Profit/Fee**

Depends on several things, including contract type, etc.

## **Escalation**

Table 6–22 contains the current DOE Escalation Rate Table.

Table 6–22. Escalation Rate Assumptions for DOE Projects (January 2003)

	,														
	Project Categories														
FY	Constr	uction	E	EM IT			0&	zΜ	R&D						
2002	1.000	N/A	1.000	N/A	1.000	N/A	1.000	N/A	1.000	N/A					
2003	1.021	2.1	1.020	2.0	1.008	0.8	1.018	1.8	1.023	2.3					
2004	1.046	2.5	1.047	2.7	1.017	0.9	1.045	2.6	1.051	2.8					
2005	1.076	2.9	1.075	2.7	1.022	0.5	1.073	2.7	1.080	2.7					
2006	1.106	2.8	1.103	2.6	1.032	1.0	1.101	2.6	1.108	2.6					
2007	1.135	2.6	1.130	2.4	1.041	0.8	1.127	2.4	1.136	2.5					
2008	1.164	2.6	1.157	2.4	1.049	0.8	1.154	2.4	1.164	2.5					

This table can be found at:

http://oecm.energy.gov/cost\_estimating/2003%20Esc%20Rates.pdf

or in DOE Field Budget Call, page D-3, at:

http://www.mbe.doe.gov/budget/guidance/fy2005/field/Call.pdf

#### **Contingency**

Tables 6–23 and 624 are contingency percentages as benchmarks. These percentages should be used in the early stages of a project, prior to any statistical (probabilistic) simulation or calculation of contingency. All contingency should be based on some assessment of risks. These percentage ranges are based primarily on information from earlier documents. Although these percentages may seem outdated, there is little data to support changing them. If a project/program or site has information contrary to this, that information should supercede this "guidance."

Table 6–23. Contingency by Project Complexity (e.g., Class 3 - Preliminary Cost Estimate)

Type of Project	Contingency
Land and Land Rights	5% to 10%
Improvements to Land/Standard Equipment	10% to 15%
New Buildings and Additions, Utilities, Other	15% to 20%
Structures	15% to 20%
Engineering	15% to 25%
Building Modifications	15% to 25%
Special Facilities (Standard)	20% to 30%
Experimental/Special Conditions	Up to 50%

Table 6-24. Contingency by Class of Estimate

Class of Cost Estimate	Contingency
Class 5 - Order of Magnitude	
Standard	20% to 30%
Experimental/Special Conditions	Up to 50%
Class 3 - Preliminary	
Standard	15% to 25%
Experimental/Special Conditions	Up to 40%
Class 1 - Definitive	5% to 15%

Table 6-25. Contingency by Type of Work

Class of Cost Estimate	Contingency
ENGINEERING	
Classes 5 - Order of Magnitude and Class 3 - Preliminary	15% to 25%
Class 1 - Definitive	10%
EQUIPMENT PROCUREMENT	
Before Bid:	
Class 5 - Order of Magnitude	15% to 25%
Class 3 - Preliminary	10% to 20%
Class 1 - Definitive	5% to 15%
After Award:	
Cost Reimbursable Contracts	15%
Fixed-Price Contracts	1% to 5%
After Delivery to Site (if no rework)	0%
CONSTRUCTION	
Prior to Award:	
Class 5 - Order of Magnitude	15% to 25%
Class 3 - Preliminary	10% to 20%
Class 1 - Definitive	5% to 15%
After Award:	
Cost Reimbursable Contracts	15% to 20%
Fixed-Price Contracts	3% to 8%

# **Start-Up Costs**

Construction start-up costs equal .5–10% of installed cost of equipment

# Section 6.12 - Lessons Learned

This section includes some cost estimating lessons that have been learned and disseminated. These may or may not be applicable, but may be worthy of consideration.

# **Lessons Learned**

(Adapted from NASA Cost Estimating Guide, Lessons Learned, by Andy Price)

- 1. Everyone is an expert on estimating costs. Get used to it.
- 2. Understand your customer's requirements. We provide a service to the Agency and that service must always be in consonance with the customer's needs.
- **3.** The work breakdown structure is the foundation of the estimate. Put it together carefully to ensure that nothing is left out and that nothing is double counted.
- **4.** Carefully document all of your ground rules and assumptions. These are the heart and soul of the estimate. Many cost estimates have been misunderstood and misused because the ground rules and assumptions were not explicit.
- **5.** A cost estimate is by definition subjective. Seek as much independent input and review as time and circumstances allow for counteracting your particular biases.
- 6. The design engineers are your friends. Work closely with them to understand the complexities of their subsystem, as well as the uncertainties. If you have not met with every lead designer on a project and captured their knowledge and understanding in the estimate, your results are no better than a ballpark guess.
- 7. Use cost models with an ounce of skepticism. They are tools based on past experience and are at best a fuzzy predictor of the future.
- **8.** The only thing certain about a cost estimate is that the final cost will be different. The real question is not how right you are but how wrong you are.
- **9.** Make sure your work is logical and defendable. If you cannot explain how you arrived at your results based on the evidence in hand, past experience, and expert judgment you will not be taken seriously.
- 10. Presentations should be clear and concise. Provide enough information to ensure that people understand how you arrived at your results, but don't get bogged down in detail (put that in the backup charts for the occasional person who wants a core drill).
- 11. Be careful with statistics and statistical analyses. Management often does not have the background to understand statistics and how they are used. If it's not explained well, it could be a detriment to the project.
- **12.** Every estimator gets reviewed or audited now and then. Don't take it personally and don't be defensive. Learn from it.
- 13. I use what I call the "half rule" to tell if my cost estimates are reasonably accurate. The "half rule" says that if half the people in the audience think your estimate is too high, and half the people think your estimate is too low, you are probably about right.
- **14.** All cost estimates should be evaluated with a sensitivity analysis. The sensitivity analysis will tell you what is and is not important to the results, and can sometimes produce

interesting surprises.

- 15. Cost estimates should be coordinated with risk assessments, and they should ensure that the range of uncertainty reflected in the cost estimate is commensurate with the range of risks to the project.
- **16.** A good cost estimate cannot overcome bad management. A cost estimate is just another piece of information that goes into the project management puzzle. You cannot (and you should not) dictate how management chooses to use that information.
- 17. You will often be pressured to produce a specific result. Be aware of that pressure and responsive to it, but don't let it override what the data and your knowledge and experience tell you.
- **18.** Consistency before truth. If you have not established a consistent, logical process to achieving the estimate, then you can neither explain your results nor do you have a basis for improvement.
- **19.** The first test of any estimate is credibility. Credibility can only be established with the help of others. Independence is determined by who provides the assessment of credibility.
- **20.** Producing a good cost estimate is an iterative process. Anyone who thinks that they can get it right the first time is naïve.
- **21.** This profession is not for sissies and wimps. Integrity and courage are required to stand up for your work.
- **22.** Question everything. Question the inputs, the models, the assumptions, and the logic of the estimate. Question everything in the search for truth. But, be careful that the questioning doesn't turn into an inquisition; you will lose credibility with your customer.

# <u>Common Errors and Rules of Thumb in Cost Estimation and Economic Evaluation</u> (adapted from the University of Oregon, PM Outline)

- Negotiating cost estimates vs. requirements
- Gold plating
- Rule of 10
- Inadequate project definition
- Misuse of contingency
- Requirements slippage
- Subjective factors and assumptions
- Overstating productivity improvements from high-technology advances

## **Twelve Common Mistakes in Making Preliminary Cost Estimates**

- 1. Errors in arithmetic. Numbers do not add up correctly; mistakes in simple calculations.
- **2.** Estimates of the Total Investment required and the Total Cost Avoidance shown on the title page of the narrative do not agree with estimates shown in the narrative and/or do not agree with estimates displayed in the spreadsheet template.
- **3.** Failure to use specified formats and templates.

- **4.** Failure to use designated rates, factors, and dollars.
- **5.** Failure to identify rates, FY dollars, and other factors used in preparing the proposal.
- **6.** "Recycling" of proposals without taking into account changes in format, rates, and time period.
- 7. Failure to provide a credible cost performance baseline. Sources of costs are not identified, calculation methodology is not given, or incorrect projections of usage and demand do not reflect the probable future course of a program.
- **8.** Failure to provide a credible estimate and methodology for investment costs, particularly for government efforts and Non-Recurring Engineering.
- **9.** Failure to provide a credible justification for basic proposal assumptions.
- **10.** *Failure to provide a clear explanation* of just what the initiative proposes to do and how implementing the initiative will result in cost avoidance.
- **11.** Failure to adjust projected cost avoidance to the proposed schedule shown in the narrative. An example would be taking full credit for cost avoidance in the first year an initiative is funded when the schedule shows it will take several years for the initiative to be fully implemented.
- **12.** Failure to provide the methodology used for calculating cost savings, or providing it in such a way that the results cannot be replicated by the examiner.

# **DOE's Lessons Learned Program**

The following topics are examples from DOE's Operating Experiences. The website referenced below provides full explanations of the lessons that have been learned:

(adapted from DOE's Lessons Learned program)

- Bundle catches fire during converter disassembly
- Bolt failure results in near miss while lifting an irradiated target
- Freeze protection reminder
- Overhead crane near miss
- A temporary window covering came loose and fell 20 feet, landing within 1 foot of a worker
- An electrician cut into an electrical conduit, narrowly missing a 480-volt energized conductor inside
- Water spray from a leaking hose entered an uninterruptible power supply system, tripping the system and damaging several circuit boards
- A 170-pound steel plate slipped out of a field-designed lifting fixture, damaging a scaffold, and narrowly missing a worker
- Flying debris from ruptured gas drying units injured three laboratory workers
- An unsecured 9-ton counterweight fell off of a flatbed truck during transport
- A QA inspector identified and confiscated a suspect bolt based on information in a

lessons-learned report

- Sparks from an abrasive wheel saw ignited a worker's personal protective clothing during a cutting operation
- Price-Anderson Enforcement Conference convened to investigate welding inspection

Information on DOE's Lessons Learned program can be obtained at: http://www.tis.eh.doe.gov/ll/index.html

Information on Best Practices established by DOE's Energy Facility Contractors Group (EFCOG) can be obtained at:

http://efcog.org/Best%20Practices/Best%20Practices.htm

Information on DOE's Environmental Management Cost Estimating and Validation Lessons Learned Workshops can be obtained at:

http://www.em.doe.gov/aceteam/training.html

# **CHAPTER 7 - REFERENCES**

SECTION 7.1 - ACRONYMS

SECTION 7.2 - DEFINITIONS

SECTION 7.3 - REFERENCES

# **Section 7.1 - Acronyms**

A/E Architect/Engineer

AACE Association for the Advancement of Cost Engineers, International

ABC Activity-Based Costing

ANSI American National Standards Institute

AS Acquisition Strategy

ASTM American Society for Testing Materials

BOE Basis of Estimate
CD Critical Decision

CDR Conceptual Design Report

CER Cost Estimating Relationship

CFO Chief Financial Officer

CFR Code of Federal Regulations

CM Construction Management

COA Code of Accounts

CPAF Cost Plus Award Fee (contract type)
CPFF Cost Plus Fixed Fee (contract type)

CPI Cost Performance Index

CPIF Cost Plus Incentive Fee (contract type)
CSI Construction Specifications Institute

CV Cost Variance

DOE U.S. Department of Energy
EIR External Independent Review

ESAAB Energy System Acquisition Advisory Board

ES&H Environment, Safety, and Health

EV Earned Value

FP Fixed Price (contract type)
FTE Full- Time Equivalents

GAO General Accounting Office **GFE** Government Furnished Equipment GPP General Plant Project **ICE Independent Cost Estimate ICR** Independent Cost Review IPT **Integrated Project Team** IR **Independent Review ISMS Integrated Safety Management System** IT Information Technology LCCA Life-Cycle Cost Analysis LOE Level of Effort LS Lump-Sum (contract type) M&I Management and Integration Contractor M&O Management and Operating Contractor MNS Mission Need Statement MR Management Reserve MS Major System NPV Net Present Value O&M Operations and Maintenance **OMB** Office of Management and Budget OPC Other Project Cost **OPEX** Operating Expense PB Performance Baseline PD **Project Director** PDS Project Data Sheet **PED** Project Engineering Design **PEP Project Execution Plan** PM Project Management or Contractor Project Manager **PMB** Performance Management Baseline **PSAR** Preliminary Safety Analysis Report QA Quality Assurance QC **Quality Control** R&D Research and Development

Society of Cost Estimating and Analysis

SCEA

SPI	Schedule Performance Index
SOW	Statement of Work
SV	Schedule Variance

TEC Total Estimated Cost
TPC Total Project Cost

UB Undistributed BudgetVE Value Engineering

WBS Work Breakdown Structure

# **Section 7.2 - Definitions**

**Acquisition Strategy (AS)** - A business and technical management approach designed to achieve acquisition objectives within the resource constraints imposed. It is the framework for planning, directing, contracting, and managing a system, program, or project. It provides a master schedule for research, development, test, production, construction, modification, postproduction management, and other activities essential for success. The AS is the basis for formulating functional plans and strategies (e.g., acquisition strategy, competition, systems engineering). Once approved, it should reflect the approving authority's decisions on all major aspects of the contemplated acquisition. See acquisition plan. (DOE PM Manual)

**Activity-Based Costing (ABC)** - Costing in a way that the costs budgeted to an account truly represent all the resources consumed by the activity or item represented in the account. (AACE) A cost estimating method where the project is divided into activities and a cost estimate is prepared for each activity.

**Allowance** - An amount included in a Base Cost Estimate to cover known but undefined requirements for a control account, work package, or planning package.

**Analysis** - Separation of a whole into its component parts; an examination of a complex thing, its elements, and their relations; a statement of such analysis.

**Bar Chart** - A graphic display of schedule-related information. In the typical bar chart, activities or other project elements are listed down the left side of the chart, dates are shown across the top, and activity durations are shown as date-placed horizontal bars. Also called a Gantt chart. (DOE PM Manual)

**Baseline** - A quantitative definition of cost, schedule, and technical performance that serves as a base or standard for measurement and control during the performance of an effort; the established plan against which the status of resources and the effort of the overall program, field program(s), project(s), task(s), or subtask(s) are measured, assessed, and controlled. Once established, baselines are subject to change control discipline.

**Basis (also basis of estimate, or BOE)** - Documentation that describes how an estimate, schedule, or other plan component was developed and defines the information used in support of development. A basis document commonly includes, but is not limited to, a description of the scope included, methodologies used, references and defining deliverables used, assumptions and exclusions made, clarifications, adjustments, and some indication of the level of uncertainty. (AACE)

**Benchmark** - Something that serves as a standard by which others may be measured or judged.

**Budgeting** - A process used to allocate the estimated cost of resources into cost accounts (i.e., the cost budget) against which cost performance will be measured and assessed. Budgeting often considers time-phasing in relation to a schedule and/or time-based financial requirements and constraints. (AACE)

**Buried Contingency** - Costs hidden in the details of estimates to protect a project from the removal of explicit contingency and so that the final project does not go over budget.

Capital Assets - Land, structures, equipment, systems, and information technology (e.g., hardware, software, and applications) that are used by the federal government and have an estimated useful life of two years or more. Capital assets include environmental restoration (decontamination and decommissioning) of land to make useful leasehold improvements and land rights, and assets whose ownership is shared by the federal government with other entities. This does not apply to capital assets acquired by state and local governments or other entities through DOE grants. (DOE PM Manual) Strategic Asset. Any unique physical or intellectual property that is of long term or ongoing value to the enterprise. As used in total cost management, it most commonly includes capital or fixed assets, but may include intangible assets. Excludes cash and purely financial assets. Strategic assets are created by the investment of resources through projects. (AACE)

**Change Order** - A unilateral order, signed by the government contracting officer, directing the contractor to make a change that the *Changes Clause* authorizes without the contractor's consent. (DOE PM Manual)

**Code of Accounts (COA)** - A systematic coding structure for organizing and managing asset, cost, resource, and schedule activity information. A COA is essentially an index to facilitate finding, sorting, compiling, summarizing, and otherwise managing information that the code is tied to. A complete code of accounts includes definitions of the content of each account. (AACE)

**Conceptual Design** - The concept of meeting a mission need. The conceptual design process requires a mission need as an input. Concepts for meeting the need are explored and alternatives considered before arriving at the set of alternatives that are technically viable, affordable, and sustainable. (DOE PM Manual)

**Conceptual Design Report (CDR)** - The CDR documents the outcome of the conceptual design phase and forms the basis for a preliminary baseline.

Construction - Any combination of engineering, procurement, erection, installation, assembly, demolition, or fabrication activities involved in creating a new facility, or to alter, add to, rehabilitate, dismantle, or remove an existing facility. It also includes the alteration and repair (including dredging, excavating, and painting) of buildings, structures, or other real property, as well as any construction, demolition, and excavation activities conducted as part of environmental restoration or remediation efforts. Construction normally occurs between Critical Decision-3 and -4. Construction does not involve the manufacture, production, finishing, construction, alteration, repair, processing, or assembling of items categorized as personal property.

Construction Management - Services that encompass a wide range of professional services relating to the management of a project during the pre-design, design, and/or construction phases. The types of services provided include development of project strategy, design review relating to cost and time consequences, value management, budgeting, cost estimating, scheduling, monitoring of cost and schedule trends, procurement, observation to ensure that workmanship and materials comply with plans and specifications, contract administration, labor relations, construction methodology and coordination, and other management efforts related to the acquisition of construction. (DOE PM Manual)

**Contingency** – The portion of the project budget that is available for uncertainty *within the project scope* but outside the scope of the contract. That is, contingency is budget that is not placed on contract. (DOE PM Manual) An amount derived from a structured evaluation of identified risks, to cover a likely future event or condition, arising from presently known or unknown causes, within a defined project scope. Contingency is controlled by the government.

## **Contingency Estimating Methods:**

**Deterministic Approach** - An approach in estimating contingency where limits or boundaries are fixed.

**Probabilistic Approach** - An approach in estimating contingency where statistical analysis is used to determine probabilities of occurrences (e.g., over-running a project's total cost).

**Contract** - A mutually binding agreement that obligates the seller to provide the specified product and obligates the buyer to pay for it. (DOE PM Manual)

**Contract Fee** - Fee earned by the contractor. It may be based on dollar value or another unit of measure, such as man-hours. This is an indirect cost. (Volume 6 Cost Guide)

## **Contract Types:**

**Cost Plus Award Fee (CPAF) Contract** - The contractor recovers actual costs incurred for completed work and is awarded a fee based on performance. Actual costs include general administration, overhead, labor and fringe benefits, other direct costs, and materials, including mark-up. (Volume 6 Cost Guide)

**Cost Plus Fixed Fee (CPFF) Contract** - The buyer reimburses the seller for the seller's allowable costs (allowable costs are defined by the contract) plus a fixed amount of profit (fee). (DOE PM Manual)

Cost Plus Incentive Fee (CPIF) Contract - A type of contract where the buyer reimburses the seller for the seller's allowable costs (allowable costs are defined by the contract) plus a fee calculated on the basis of defined performance criteria. (DOE PM Manual)

**Fixed Price (FP, or Lump-Sum) Contracts** - Fixed price contracts provide for a firm price or, under appropriate circumstances, may provide for an adjustable price for the supplies or services that are being procured. In providing for an adjustable price, the contract may fix a ceiling price, target price (including target cost), or minimum price. Unless otherwise provided in the contract, any such ceiling, target, or minimum price is subject to adjustment only if required by the operation of any contract clause that provides for equitable adjustment, escalation, or other revision of the contract price upon the occurrence of an event or a contingency. (DOE PM Manual)

**Fixed Price Incentive Fee (FPIF) Contract** - Where the buyer pays the seller a set amount (as defined by the contract), and the seller can earn an additional amount if it meets or exceeds defined performance criteria. (DOE PM Manual)

**Labor-Hour Contracts** - Where costs and fees are paid based on the number of labor hours worked. Normally associated with the use of "loaded" labor rates.

**Unit-Cost Contracts** -Where costs and fees are paid based on the number of units produced or delivered. These unit costs normally include direct costs, indirect costs, overheads, and profit, and are established per some unit of measure.

**Task Order Contracts** - Where tasks are established and managed within the general scope of a contract.

**Contractor** - Includes all persons, organizations, departments, divisions, and companies having contracts, agreements, or memoranda of understanding with the DOE or another federal agency.

**Control Account (or Cost Account)** - A management control point at which budgets (resource plans) and actual costs are accumulated and compared to earned value for management control purposes. A control account is a natural management point for planning and control since it represents the work assigned to one responsible organizational element on one work breakdown structure element. (DOE PM Manual)

**Cost Accounting** - The historical reporting of actual and/or committed disbursements (costs and expenditures) on a project. Costs are denoted and segregated within cost codes that are defined in a chart of accounts. In project control practice, cost accounting provides the measure of cost commitment and/or expenditure that can be compared to the measure of physical completion (or earned value) of an account. (AACE)

**Cost Budgeting** - Allocating the cost estimates to individual project components. (DOE PM Manual)

**Cost Control** - Controlling changes to the project budget and forecast to completion. (DOE PM Manual)

**Cost Estimate** - A documented statement of costs to be incurred to complete a project or a defined portion of a project. (DOE PM Manual) Cost estimates provide input to budget, contract, or project management planning for baselines and changes against which performance may be measured.

#### **Cost Estimate Classifications:**

**Class 5 - Order-of-Magnitude -** Stochastic, Most Parametric, Judgment Techniques used include: Parametric, Specific Analogy, Expert opinion, Trend Analysis.

**Class 4 - Intermediate -** More Parametric (Techniques: Parametric, Specific Analogy, Expert opinion, Trend Analysis)

**Class 3 - Preliminary -** Various including combinations (Techniques: Detailed, Unit-Cost, or Activity Based, Parametric, Specific Analogy, Expert Opinion, Trend Analysis)

**Class 2 - Intermediate -** More Definitive (Techniques: Detailed, Unit-Cost, or Activity Based, Expert Opinion, Learning Curve)

**Class 1 - Definitive -** Deterministic, Most Definitive (Techniques: Detailed, Unit-Cost, or Activity Based, Expert Opinion, Learning Curve)

**Cost Estimating** - A predictive process used to quantify, cost, and price the resources required by the scope of an asset investment option, activity, or project. As a predictive process, estimating must address risks and uncertainties. The outputs of estimating are used primarily as inputs for budgeting, cost or value analysis, decision making in business, asset and project

planning, or for project cost and schedule control processes. (AACE)

# **Cost Estimating Techniques:**

**Detailed, Unit-Cost, or Activity-Based** - The most definitive of the estimating techniques and includes information down to the lowest level of detail available, where each activity is further broken down so that labor hours, material costs, equipment costs, and subcontract costs (or other unit-cost-type items) are itemized and quantified. Subtotaled, these form direct costs. Indirect costs, overhead costs, contingency, and escalation are then added, as necessary. The estimate may be revised as the known detail is refined. The Detailed, Unit-Cost, or Activity Based estimating technique is most used for the Class 1 and 2 cost estimates.

Activity-Based Cost estimates (or ABC estimates), detailed cost estimates, check estimates, bid estimates, construction estimates, and other terms imply that activities, tasks, work packages, or planning packages (the lowest level of the WBS) are well-defined, quantifiable, and are to be tracked, so that performance can accurately be measured. Quantities should be objective, discreet, and measurable.

Cost Estimating Relationship (CER) - An algorithm or formula that is used to perform the costing operation. A CER shows some resource (e.g., cost, quantity, or time) as a function of one or more parameters that quantify scope, execution strategies, or other defining elements. A CER may be formulated in a manner that, in addition to providing the most likely resource value, also provides a probability distribution for the resource value. Cost estimating relationships may be used in either definitive or parametric estimating methods. (Adapted from AACE) Also known as cost models, composites, or assemblies/sub-assemblies, CERs are developed from historical data by similar systems or subsystems. CERs are correlations of cost drivers and system parameters, such as design, or performance requirements (a quantity of something). A CER can be used individually or grouped into more complex models. A limitation of the use of a CER is that, to be most effective, one must understand completely how the CER was developed and where and how indirect costs, overhead costs, contingency, and escalation are applicable.

**Definitive Estimate** - In estimating practice, describes estimating algorithms or cost estimating relationships that are not highly probabilistic in nature (i.e., the parameters or quantification inputs to the algorithm tend to be conclusive or definitive representations of the scope). Typical definitive estimate algorithms include, but are not limited to, detailed unit and line-item cost techniques (i.e., each specific quantified item is listed and costed separately). (1/03) (AACE)

**Expert Opinion** - An estimating technique whereby specialists are consulted until a consensus can be established, regarding the cost of a program, project, sub-project, task, or activity. The Expert Opinion technique is most appropriate in the early stages of a project, for Classes 5, 4, and 3, Order of Magnitude, Intermediate, and Preliminary cost estimates.

Learning Curve - A way to understand efficiency of large quantities.

Level of Effort (LOE) - A form of parametric estimating. The effort of a general or supportive nature usually without a deliverable end product. An activity (e.g., vendor or customer liaison) that does not readily lend itself to measurement of accomplishment. May be characterized by a uniform rate of activity over a specific period of time. Examples are supervision, program administration, and contract administration. LOE tasks receive budgeted cost for work performed, based upon the passage of time, not measured output. (Adapted from DOE PM Manual)

**Parametric, or Top-Down** - In estimating practice, describes estimating algorithms or cost estimating relationships that are highly probabilistic in nature (i.e., the parameters or quantification inputs to the algorithm tend to be abstractions of the scope). Typical parametric algorithms include, but are not limited to, factoring techniques, gross unit costs, and cost models (i.e., algorithms intended to replicate the cost performance of a process of system). Parametric estimates can be as accurate as definitive estimates. (1/03) (AACE) Produces higher-level estimates when little information, other than basic parameters, is known about a project. The Parametric estimating technique is most appropriate for the Classifications 5, 4, and 3. The parametric technique is best used when the design basis has evolved very little detail but the overall parameters have been established.

**Specific Analogy** - Uses known cost of an item as an estimate for a similar item in a new system. Adjustments are made to known costs to account for differences in relative complexities of performance, design, and operational characteristics. The Specific Analogy technique is most appropriate in the early stages of a project, for Classifications 5, 4, and 3.

**Trend Analysis** - An estimating technique utilizing current, in-progress work using efficiency indices (CPI and SPI) derived by comparing originally planned costs against actual costs for work performed and planned. The derived indices are used to adjust estimate of work not yet completed. The Trend Analysis technique of cost estimating may be used in most any stage of project development, and may be used to update cost estimates developed using other techniques.

**Critical Decision (CD)** - A formal determination made by the Acquisition Executive and/or designated official at a specific point in a project life cycle that allows the project to proceed. Critical Decisions occur in the course of a project. For example prior to commencement of conceptual design, commencement of execution, and turnover. (DOE PM Manual)

#### **Critical Decisions:**

CD-0, Approve Mission Need

CD-1, Approve Alternative Selection and Cost Range

**CD-2, Approve Performance Baseline** 

**CD-3**, Approve Construction Start

CD-4, Approve Start of Operations or Project Closeout

**Deviation** - Occurs when the current estimate of a performance, technical, scope, schedule, or cost parameter is not within the threshold value of the Performance Baseline for that parameter. It is handled as a deviation, not through the normal change control system. (DOE PM Manual)

**Direct Costs** - Any costs that can be specifically identified with a particular project or activity, including salaries, travel, equipment, and supplies directly benefiting the project or activity. (Volume 6 Cost Guide)

**Discount Rate** - The interest rate used in calculating the present value of expected yearly benefits and costs. (OMB)

**Nominal Interest Rate** - An interest rate that is not adjusted to remove the effects of actual or expected inflation. Market interest rates are generally nominal interest rates. (OMB)

**Real Interest Rate** - An interest rate that has been adjusted to remove the effect of expected or actual inflation. Real interest rates can be approximated by subtracting the expected or actual inflation rate from a nominal interest rate. (A precise estimate can be obtained by dividing one plus the nominal interest rate by one plus the expected or actual inflation rate, and subtracting one from the resulting quotient.) (OMB)

**DOE Acquisition Management System** - Systematic acquisition to deliver a product or capability in response to a programs mission or business need. Acquisitions covered are facility construction, infrastructure repairs or modifications, system, production capability, remediated land, closed site, disposal effort, software development, information technology, space system, research capability, or other asset.

**DOE requirements** - Requirements of the Department of Energy, as contained in the DOE Directives System as DOE Notices, Policies, and Orders. Normally these requirements are passed down from the Office of Management and Budget or congressional actions.

**Duration** - The number of work periods (not including holidays or other non-working periods) required to complete an activity or other project element. Usually expressed as workdays or workweeks. Sometimes incorrectly equated with elapsed time. (DOE PM Manual)

**Earned Value (EV)** - (1) A method for measuring project performance. It compares the value of work performed (Earned Value (EV), formerly known as Budgeted Cost of Work Performed, or BCWP) with the value of work scheduled (Planned Value (PV), formerly known as Budgeted Cost of Work Scheduled, or BCWS) and the cost of performing the work (Actual Cost (AC), formerly known as Actual Cost of Work Performed) for the reporting period and/or cumulative to date. (2) The EV for an activity or group of activities. (DOE PM Manual)

#### **Earned Value Terms:**

Actual Cost (AC, formerly Actual Cost of Work Performed - ACWP) - Total costs incurred (direct and indirect) in accomplishing an identified element or scope of work during a given time period. (DOE PM Manual)

**Budget at Completion (BAC)** - The total budget for accomplishing the program scope of work. It is equal to the sum of all allocated budgets plus any undistributed budget. (Management Reserve is not included.) The Budget at Completion will form the Performance Baseline. (DOE PM Manual)

**Cost Performance Index (CPI)** - The cost efficiency ratio of Earned Value to Actual Costs (CPI = EV/AC). Used to estimate costs at completion by using the following formula: EAC = BAC/CPI.

**Cost Variance (CV)** - The difference between earned value and actual cost (CV = EV - AC). A positive value indicates a favorable condition and a negative value indicates an unfavorable one. (DOE PM Manual)

**Estimate at Completion (EAC)** - The current estimated cost for program-authorized work. (EIA-748) (DOE PM Manual)

**Estimate to Complete (ETC)** - Estimate of costs to complete all work from a point in time to the end of the project or program. (DOE PM Manual)

**Earned Value (EV, formerly Budgeted Cost of Work Performed - BCWP) -** The sum of the approved cost estimates (including any overhead allocation) for activities (or portions of activities) completed during a given period (usually project-to-date). See also earned value. (DOE PM Manual)

Planned Value (PV, formerly Budgeted Cost of Work Scheduled - BCWS) - The sum of the approved cost estimates (including any overhead allocation) for activities (or portions of activities) scheduled to be performed during a given period (usually project-to-date). See also Earned Value. (DOE PM Manual)

**Schedule Performance Index (SPI)** - The schedule efficiency ratio of Earned Value to Planned Value (SPI = EV/PV).

**Schedule Variance (SV)** - The algebraic difference between Earned Value and the budget, or Planned Value (SV = EV - PV). A positive value is a favorable condition while a negative value is unfavorable. The SV is calculated in dollars or work units and is intended to compliment network analysis, not supercede or replace it. (DOE PM Manual)

**Escalation** - Cost increases caused by unit price increases. Whereas the cost of projects can increase because of poor management, scope growth, and schedule delays, economic escalation is concerned only with forecasting price increases caused by an increase in the cost of labor, material, or equipment necessary to perform the work. (Volume 6 Cost Guide)

**External Independent Review (EIR)** - Mandated by congress to be performed for projects of significant size and complexity. May warrant management attention. (DOE PM Manual)

**Facilities** - Buildings and other structures; their functional systems and equipment, including site development features, such as landscaping, roads, walks, and parking areas; outside lighting and communications systems; central utility plants; utilities supply and distribution systems; and other physical plant features. (DOE PM Manual)

**Federal Requirements** - Requirements of the federal government, typical for all executive branch agencies, normally as expressed by the Office of Management and Budget (OMB) or laws and regulations provided by congress.

**General Plant Projects (GPP)** - Congress has recognized DOE's need to provide for miscellaneous construction items that are required during the fiscal year and which cannot be specifically identified beforehand. Congress provides, annually, an amount for these purposes under the title of General Plant Projects. (DOE PM Manual)

**Government Estimates** - Determines the reasonableness of competitive bids received in connection with fixed-price construction contracts and serves as a control in evaluating cost estimates prepared by a prime cost-type construction contractor. Sometimes called an engineer's estimate. (Volume 6 Cost Guide)

**Historical Cost Information** - A database of information from completed projects. This data is normalized to some standard (geographical, national average, etc.) and is time-based (e.g., brought to current year) using historical cost indices.

**Improvements to Land** - The cost of general site clearing, grading, drainage, and facilities common to the project as a whole (such as roads, walks, paved areas, fences, guard towers, railroads, port facilities, etc.), but excluding individual buildings, other structures, utilities, special equipment/process systems, and demolition, tunneling and drilling when they are a significant intermediate or end product of the project. (Volume 6 Cost Guide)

**Independent Cost Estimate (ICE)** - A Detailed, Unit-Cost, or Activity-Based documented, independent cost estimate that has the express purpose of serving as an analytical tool to validate, crosscheck, or analyze cost estimates developed by project proponents. (DOE PM Manual)

**Independent Cost Review (ICR)** - An essential project management tool used to analyze and validate an estimate of project costs. An independent cost review is typically conducted on all projects at the point of baseline approval. Such reviews may be required by Congress, DOE management, Headquarters program offices, or field project management staff. The requiring office or agency will provide specific requirements for such reviews. An ICR may be performed by an independent internal or external organization. (DOE PM Manual)

**Indirect Costs** - Costs incurred by an organization for common or joint objectives, and which cannot be identified specifically with a particular activity or project. (Volume 6 Cost Guide)

**Inflation** - The proportionate rate of change in the general price level, as opposed to the proportionate increase in a specific price. (OMB)

**Information Technology (IT) Project** - A type of project that primarily consists of establishing a system (hardware and/or software) capability to manage information.

**Integrated Project Schedule** - An integrated project schedule contains all the elements of the overall project, including the design and engineering, procurement, construction, R&D, safety, environmental, and operations activities. An integrated project schedule would cover preauthorization through construction activities. (Volume 6 Cost Guide)

**Integrated Project Team (IPT)** - An IPT is a cross-functional group of individuals organized for the specific purpose of delivering a project to an external or internal customer. (DOE PM Manual)

**Integrated Safety Management System (ISMS)** - An overall management system designed to ensure that environmental protection and worker and public safety are appropriately addressed in the planning, design, and performance of any task. (DOE PM Manual)

**Life Cycle** - The stages or phases that occur during the lifetime of an object or endeavor. A life cycle presumes a beginning and an end, with each end implying a new beginning. In life cycle cost or investment analyses, the life cycle is the length of time over which an investment is analyzed (i.e., study period). (AACE)

**Life Cycle Cost** - The overall estimated cost for a particular program alternative over the time period corresponding to the life of the program, including direct and indirect initial costs plus any periodic or continuing costs of operation and maintenance. (OMB) The sum total of the direct, indirect, recurring, nonrecurring, and other related costs incurred or estimated to be incurred in the design, development, production, operation, maintenance, support, and final disposition of a major system over its anticipated useful life span. Where system or project planning anticipates use of existing sites or facilities, restoration, and refurbishment costs should be included. (DOE PM Manual)

**Life-Cycle Cost Analysis (LCCA)** - An analysis of the direct, indirect, recurring, non-recurring, and other related costs incurred or estimated to be incurred in the design, development, production, operation, maintenance, support, and final disposition of a major system over its anticipated useful life span. (Volume 6 Cost Guide)

**Line-Item Projects** - Projects that are specifically reviewed and approved by Congress. Projects with a total project cost greater than \$5 million are categorized as line-item projects. (DOE PM Manual)

**Major System (MS)** - Any project or system of projects having a TPC of \$400 million or greater, or designated by the Deputy Secretary. (DOE PM Manual)

**Management Reserve (MR)** - An amount of the total allocated budget withheld for management control purposes by the contractor. Management Reserve is not part of the Performance Measurement Baseline. (DOE PM Manual)

**Mission Need** - A required capability within DOE's overall purpose, including scope, cost, and schedule considerations. When the mission analysis or studies directed by appropriate executive or legislative authority identify a deficiency in existing capabilities or an opportunity, this will be set forth as justification for purposes of system acquisition approvals, planning, programming, and budget formulation. (DOE PM Manual)

**Net Present Value (NPV)** - The difference between the discounted present value of benefits and the discounted present value of costs. (OMB)

**Operation** – An ongoing endeavor or activity that utilizes strategic assets for a defined function or purpose. (AACE)

**Optimization** - Techniques that analyze a system with the goal of finding an optimum result. Finding an optimum result usually requires evaluating design elements, execution strategies and methods, and other system inputs for their effects on cost, schedule, safety, or some other set of outcomes or objectives. Commonly employs computer simulation and mathematical modeling. (1/03) (AACE)

**Other Project Costs (OPC)** - Costs related to engineering, development, startup, and operations. These activities/costs and allowances are essential for project execution, but they are not considered part of the normal capital system/facility acquisition cost. They are operating/expense funded. (DOE PM Manual)

**Performance-Based Management, Contracting, and Budgeting** - Where costs and performance are tied to quantities, establish a baseline, and are regularly reported to assess performance (for various purposes).

**Performance Baseline (PB)** - A quantitative expression reflecting total scope of a project with integrated technical, schedule, and cost elements. It is the established risk-adjusted, time-phased plan against which the status of resources and the progress of a project(s) are measured, assessed, and controlled. It is a federal commitment to OMB and Congress. Once established, PBs are subject to change control. (adapted from DOE PM Manual) Represents a project's Total Project Cost after Critical Decision 2, Approval of Performance Baseline.

**Preliminary Design** - Continues the design effort utilizing the conceptual design and the project design criteria as a basis for project development. Preliminary design develops topographical and subsurface data and determines the requirements and criteria that will govern the definitive design. Tasks include preparation of preliminary planning and engineering studies, preliminary drawings and outline specifications, life cycle cost analyses, preliminary cost estimates, and scheduling for project completion. Preliminary design provides identification of long-lead procurement items and analysis of risks associated with continued project development. Preliminary design occurs between Critical Decision-1 and -2. (DOE PM Manual)

**Productivity** - Consideration for factors that affect the efficiency of construction labor (e.g., location, weather, work space, coordination, schedule). This is a direct cost. (Volume 6 Cost Guide)

**Program** - An organized set of activities directed toward a common purpose or goal undertaken or proposed in support of an assigned mission area. A program is characterized by a strategy for accomplishing a definite objective(s), which identifies the means of accomplishment, particularly in quantitative terms, with respect to manpower, materials, and facilities requirements. Programs usually include an element of ongoing activity and are typically made up of technology-based activities, projects, and supporting operations. See acquisition program/project. (DOE PM Manual)

**Project** - In general, a unique effort that supports a program mission, having defined start and end points, undertaken to create a product, facility, or system, and containing interdependent activities planned to meet a common objective or mission. A project is a basic building block in relation to a program that is individually planned, approved, and managed. A project is not constrained to any specific element of the budget structure (e.g., operating expense or plant and capital equipment). Construction, if required, is part of the total project. Authorized, and at least partially appropriated, projects will be divided into two categories: major system projects and other projects. Projects include planning and execution of construction, renovation, modification, environmental restoration, decontamination and decommissioning efforts, and large capital equipment or technology development activities. Tasks that do not include the above elements, such as basic research, grants, ordinary repairs, maintenance of facilities, and operations, are not considered projects. See acquisition program/project. (DOE PM Manual)

**Project Data Sheet (PDS)** - A generic term defining the document that contains summary project data and the justification required to include the entire project effort as a part of the Departmental budget. PDSs are submitted to request PED funds and construction funds. Specific instructions on the format and content of PDSs are contained in the annual budget call and DOE O 5100.3, Field Budget Process [DOE O 130.1, Budget Formulation]. (DOE PM Manual)

**Project Engineering and Design (PED)** - Design funds established for use on preliminary design, which are Operating Expense funds. (DOE PM Manual)

**Project Execution Plan (PEP)** - The plan for execution of a project, which establishes roles and responsibilities and defines how a project will be executed. (DOE PM Manual)

**Project Life Cycle** - A collection of generally sequential project phases whose name and number are determined by the control needs of the organization or organizations involved in the project. (DOE PM Manual) The stages or phases of project progress during the life of a project. Project life cycle stages typically include ideation, planning, execution, and closure. (AACE)

**Project Management** - A management approach in which authority and responsibility for execution are vested in a single individual, to provide focus on the planning, organizing, directing, controlling, and closing of all activities within a project. (adapted from the DOE PM Manual)

**Project Director** - A DOE (federal) project manager. Project Directors are project investors, strategists, developers, and contract managers.

**Project Manager** - A contractor project manager. Responsible for the day-to-day management of a project and delivering the means, methods, and resources to meet the contract end point requirements and achieve project success.

**Project Support** - Support covers those activities performed by the Operating Contractor for internal management and technical support of the Project Manager. (Volume 6 Cost Guide)

**Range, or Cost Estimate** - An expected range of costs for a project or its components. Ranges may be established by ranges of alternatives, confidence levels, or expected accuracy, and are dependent on a project's stage of development, size, complexity, and other factors.

**Real Property** - Land and/or improvements including interests therein, except public domain land. (DOE PM Manual)

**Reconciliation** - A comparison of a current estimate to a previous estimate to ensure that the differences between the two are appropriate and reasonably expected. A formal reconciliation may entail an account of those differences.

**Resource** - In planning and scheduling, a resource is any consumable, except time, required to accomplish an activity. From a total cost and asset management perspective, resources may include any real or potential investment in strategic assets including time, money, human, and physical. A resource becomes a cost when it is invested or consumed in an activity or project. (AACE)

**Review** - A determination of project or system acquisition conditions based on a review of project scope, cost, schedule, technical status, and performance in relation to program objectives, approved requirements, and baseline project plans. Reviews provide critical insight into the plans, design, cost, schedule, organization, and other aspects of a project.

**Objective Reviews** - Reviews assessed, based on set criteria. A checklist approach to reviewing.

**Subjective Reviews** - Reviews assessed, based on subjective criteria. Management Reviews involve criteria and areas that are flexible to reflect management concerns or perceived weaknesses.

**Review Criteria** - Elements that, when used in a review, should reflect the general nature of a project's (or project element's) content.

**Risk** - A measure of the potential inability to achieve overall project objectives within defined cost, schedule, and technical constraints. Risk has two components: (1) the *probability/likelihood* of failing to achieve a particular outcome, and (2) the *consequences/impacts* of failing to achieve that outcome.

**Risk Management** - The act or practice of controlling risk. An organized process that reduces the risk of an activity or project, which will maximize the potential for success of the activity. (DOE PM Manual)

**S-Curve (also Spending-Curve or Funding Profile)** - Graphic display of cumulative costs, labor hours, or other quantities plotted against time. The name derives from the S-like shape of the curve (flatter at the beginning and end, steeper in the middle) produced on a project that starts slowly, accelerates, and then tails off. (DOE PM Manual) A representation of the project costs over the life of the project.

**Schedule** - A plan that defines when specified work is to be done to accomplish program objectives on time. (DOE PM Manual)

**Scope** - The sum of all that is to be or has been invested in and delivered by the performance of an activity or project. In project planning, the scope is usually documented (i.e, the scope document), but it may be verbally or otherwise communicated and relied upon. Generally limited to that which is agreed to by the stakeholders in an activity or project (i.e., if not agreed to, it is out of scope.). In contracting and procurement practice, includes all that an enterprise is contractually committed to perform or deliver. (1/03) (AACE)

**Special Equipment** - The installed cost of large items of special equipment and process systems, such as vessels, (e.g., towers, reactors, storage tanks), heat transfer systems (e.g., heat exchangers, stacks, cooling towers, de-superheaters), package unites (e.g., waste treatment packages, clarifier packages, sulfurization, demineralization), and process piping systems. (Volume 6 Cost Guide)

**Standard Equipment** - Items of equipment in which only a minimum of design work is required, such as off-the-shelf items. Examples include office furniture, laboratory equipment, heavy mobile equipment, etc. Includes spare parts that are made part of the capital cost. This is a direct cost. (Volume 6 Cost Guide)

**Start-up** – Start-up covers one-time costs incurred by the Management and Operating Contractor during the transition period between the completion of construction and the operation of the facility. (Volume 6 Cost Guide)

**Statement of Work (SOW)** - A narrative description of products or services to be supplied under contract. (DOE PM Manual)

**"Successful Projects"** - A project completed, or expected to be completed, within the technical, cost, and schedule aspects of the performance baseline.

**Total Cost Management** - As defined in AACE International's Constitution and Bylaws; the effective application of professional and technical expertise to plan and control resources, costs, profitability, and risks. Simply stated, it is a systematic approach to managing cost throughout the life cycle of any enterprise, program, facility, project, product, or service. This is accomplished through the application of cost engineering and cost management principles, proven methodologies, and the latest technology in support of the management process. Can also be considered the sum of the practices and processes that an enterprise uses to manage the total life cycle cost investment in its portfolio of strategic assets. (AACE)

**Total Estimated Costs (TEC)** - The TEC of a project is the specific cost of the project, whether funded as an operating expense or construction. It includes the cost of land and land rights; engineering, design, and inspection costs; direct and indirect construction costs; and the cost of initial equipment necessary to place the plant or installation in operation, whether funded as an operating expense or construction. In recent years, Congress has authorized amounts for projects exclusive of amounts for the construction planning and design. In these cases, the amount authorized is used as a base for TEC, even though it does not include planning and design costs. These costs are typically capitalized. (DOE PM Manual)

**Total Project Cost (TPC)** - The TPC is synonymous with the cost of the APB. It consists of all costs included in the Total Estimated Cost (TEC) of a project plus Other Project Costs (OPC), such as pre-construction costs, that include conceptual design and research and development, as well as costs associated with the pre-operational phase, such as training and start-up. In budget terms, it is the sum of the technical baseline, schedule baseline, and cost baseline. It includes all research and development, operating, plant, and capital equipment costs specifically associated with project construction and may, when planned, go up to the point of routine operations. (DOE PM Manual)

**Trending** - The systematic tracking of performance against established, or planned, objectives.

**Undistributed Budget (UB)** - Budget associated with specific work scope or contract changes that has not been assigned to a control account or summary-level planning package. (DOE PM Manual)

**Validation** - The process of evaluating project planning, development, baselines, and proposed funding prior to inclusion of a new project or system acquisition in the DOE budget. (DOE PM Manual)

More information on Budget Validation can be found in the FY2005 Field Budget Handbook, available at: http://www.cfo.doe.gov/budget/guidance/fy2005/field/Handbook.pdf.

**Value Management** - An organized effort directed at analyzing the functions of systems, equipment, facilities, services, and supplies for the purpose of achieving the essential functions at the lowest life-cycle cost, consistent with required performance, quality, reliability, and safety. (DOE PM Manual)

Work Breakdown Structure (WBS) - A product-oriented grouping of project elements that organizes and defines the total scope of the project. The WBS is a multi-level framework that organizes and graphically displays elements representing work to be accomplished in logical relationships. Each descending level represents an increasingly detailed definition of a project component. Project components may be products or services. It is the structure and code that integrates and relates all project work (technical, schedule, and cost) and is used throughout the life cycle of a project to identify and track specific work scopes. (DOE PM Manual)

Work Package - A task or set of tasks performed within a control account. (DOE PM Manual)

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